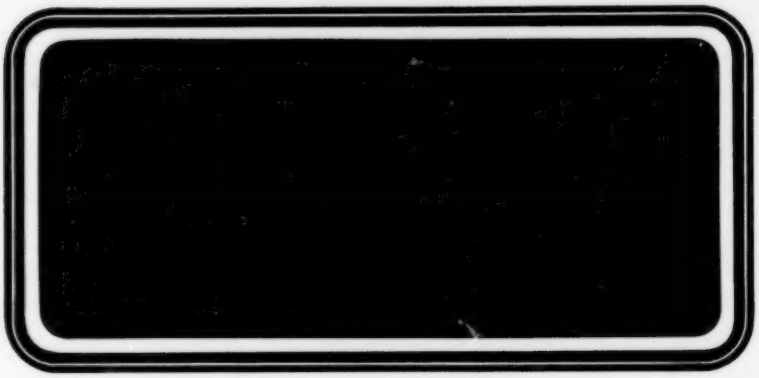
Canada Alberta

FOREST RESOURCE DEVELOPMENT AGREEMENT
ENTENTE SUR LA MISE EN VALEUR DES RESSOURCES FORESTIERES



Canada Alberta

The Canada-Alberta Forest Resource Development Agreement is a subsidiary agreement of the Canada-Alberta Economic and Regional Development Agreement, which provides coordination and cooperation between the governments of Alberta and Canada in areas of Alberta's economic development.

The Canada-Alberta Forest Resource Development Agreement is funded equally by the governments of Canada and Alberta, from April 1, 1984, to March 31, 1989.

Its primary objectives are to ensure the long-term availability of timber supplies; to optimize timber uses; and to contribute to the growth and diversification of Alberta's economy.

The Agreement comprises three programs: Reforestation; Applied research, technology transfer and opportunity identification; and Public information, evaluation and administration. These programs are managed by a joint Directorate and are implemented by the Canadian Forestry Service and the Alberta Forest Service.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est auxiliaire à l'Entente Canada-Alberta sur le développement économique et régional, qui vise à assurer la coordination et la coopération des deux gouvernements relativement au développement économique de l'Alberta.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est financée à parts égales par les gouvernements du Canada et de l'Alberta, et a cours du 1er avril 1984 au 31 mars 1989.

Ses objectifs principaux sont assurer la disponibilité à long terme de réserves de bois; optimiser leur utilisation; et contribuer à la croissance et la diversification de l'économie de la province.

L'Entente comprend trois programmes: Reboisement; Recherche appliquée, transferts de connaissances techniques et relevé des occasions; et Information, évaluation et administration. Ces programmes sont gérés par un Bureau de direction conjoint, et mis en oeuvre par le Service canadien des forêts et le Service forestier de l'Alberta.

For more information, please call or write:

Pour de plus amples informations, veuillez vous adresser à:

Canadian Forestry Service
Northern Forestry Centre
5320 - 122 Street
Edmonton, Alberta
T6H 3S5
Telephone: (403) 435-7210
Attention: S. Price

OR/OU Alberta Department of
Forestry, Lands & Wildlife
9915 - 108 Street
Edmonton, Alberta
T5K 2C9
Telephone: (403) 427-3583
Attention: D. Fregren

A TUTORIAL FOR GRADING ASPEN, BIRCH AND OTHER CANADIAN HARDWOODS

Eugene M. Wengert
Department of Forest Products[1]
1988

This is a joint publication of the Canadian Forestry Service and the Alberta Forest Service pursuant to the Canada-Alberta Forest Resource Development Agreement

[1]Virginia Polytechnic Institute and State University
Brooks Forest Products Center
Blacksburg, VA 24061-0503

89-05245/

DISCLAIMER

The study on which this report is based was funded in part under the Canada/Alberta Forest Resource Development Agreement.

The views, conclusions and recommendations are those of the authors. The exclusion of certain manufactured products does not necessarily imply disapproval nor does the mention of other products necessarily imply endorsement by the Canadian Forestry Service or the Alberta Forest Service.

(c) Minister of Supply and Services Canada 1987

ISBN: 0-662-16345-1

Catalogue No.: 42-91/51-1988E

Additional copies for this publication are available at no charge from:

Regional Development
Canadian Forestry Service
5320 - 122nd Street
Edmonton, Alberta
T6H 3S5
Telephone: (403) 435-7210

or

Forestry, Lands and Wildlife
Forest Industry Development Division
108th Street Building
#930, 9942 - 108th Street
Edmonton, Alberta
T5K 2J5
Telephone: (403) 422-7011

ABSTRACT

This report is intended to be used for teaching the hardwood lumber grading rules as promulgated by the National Hardwood Lumber Association. Instruction begins with the measurement of lumber and proceeds through the basic steps of grading. The rules for the commonly used grades are included, as well as the modifications for aspen and birch. Many exercises are included to illustrate the various aspects of grading hardwood lumber.

A TUTORIAL FOR GRADING ASPEN, BIRCH, AND OTHER CANADIAN HARDWOODS

Table of Contents

Chapter		Page
1	Introduction	1
2	Board Foot and Surface Measure	3
3	Cuttings	14
4	Steps in Grading	19
5	FAS Rules (Para. 53-64)[3]	22
6	No.1 Common Rules	29
7	Select Rules	30
8	No.2, 3A, and 3B Common Rules	31
9	F1F ("One Face") Rules	33
10	Species Variations	34
11	Grading Practice and Quiz	35
12	Exercises and Answers	40

List of Figures

Figure 1 A lumber grading stick.

Figure 2 A lumber grading stick in use on a piece of lumber 7-3/8" wide, with the side for even length lumber showing.

Figure 3 A lumber grading stick with the SM regions and thickness gauge illustrated, with the side for even length lumber showing.

Figure 4 A close-up view of a scaling stick in use with lumber 7-3/8" wide.

Figure 5 The dividing point for short lumber.

Figure 6 Lumber is divided into clear cuttings. This shows two possible divisions.

Figure 7 Knots or holes are measured for size by averaging the smallest and largest dimensions.

Figure 8 Typical pieces of lumber for several of the standard hardwood lumber grades. Shown is the grading face.

Figure 9 The 97% rule permits two clear-face cuttings of any length, full width that total 11.64 SM.

Figure 10 Pith is limited in FAS.

Figure 11 Wane rule illustrations for FAS.

Figure 12 Length of splits over 12" long are limited in FAS.

Figure 13 The end foot rule in FAS.

Figure 14. Various lumber widths (the numbered, dark lines) used in Exercise 2 and 3.

Figure 15. Various lumber widths (the numbered, dark lines) used in Exercise 2.

Note: Many of the Figures are based on figures from How to Edge and Trim Hardwood Lumber by F.J. Petro. 1982. Publication SP 507E. Forintek Canada Corp. Eastern Laboratory (Ottawa). Others are based on Simplified Guidelines to Hardwood Lumber Grading by W.R. Smith. 1967. Unnumbered publication. USDA Forest Service, Southeastern Forest Experiment Station, Asheville, NC.

List of Tables

Table 1. Example of Length Measurement.

Table 2. Thickness Variation Permitted.

Table 3. Example of Thickness Measurement:

Table 4. Examples of SM Calculation.

Table 5. The SM's for Even Length Lumber, 7-3/8" Wide.

Table 6. The SM's for Odd Length Lumber, 7-3/8" Wide.

Table 7. The SM's for Short Lumber, 7-3/8" Wide.

Table 8. Multiplication of Fractions.

Table 9. The Ten Steps for Grading Hardwood Lumber.

Chapter 1 INTRODUCTION

Hardwoods in North America, indeed throughout much of the world, are graded on the basis of procedures and rules established by the NHLA[1]. With thousands of members in the United States and Canada today, this Association established the present grading system in 1932. Since that time, billions of board feet of hardwood lumber have been graded using the Association's rules. The fundamental philosophy of the standard rules is to estimate the value of the lumber when it is to be cut into clear, defect free parts for furniture, millwork, and cabinetry.

The rules for grading lumber are contained in the NHLA's book Rules for the Measurement & Inspection of Hardwood and Cypress. The rules are updated from time to time.

Short courses to teach the fundamentals of lumber grading are given throughout North America. These courses vary in length, but are usually at least 20 hours long. Only a brief introduction can be given in such a short time period--further practice and training is necessary to develop a top-notch grader. The NHLA conducts longer training schools in their Memphis training facility that produces well trained and qualified graders.

This written tutorial is divided into 9 parts or lessons, corresponding to the typical short course topics. It is suggested that the lessons be covered sequentially.

Lesson 1. Board Foot Measurement and Surface Measure

Lesson 2. Cuttings

Lesson 3. Steps in Grading

Lesson 4. FAS Rules

Lesson 5. No.1 Common Rules

Lesson 6. Select Rules

Lesson 7. No.2, 3A, and 3B Common Rules

Lesson 8. F1F ("One face") Rules

Lesson 9. Species variations

---

[1] National Hardwood Lumber Association, P. O. Box 34518, Memphis, TN 38184 USA

This tutorial presents some of the key points of hardwood lumber grading, especially those relevant to aspen and birch. This material is intended to be used as part of a short course or in conjunction with Virginia Tech's computerized tutorial.[2]

This tutorial is illustrated to assist in learning, with examples, work sheets and quizes also provided. In all cases, the student must have an NHLA rule book which contains the complete rules and all the various special cases and exceptions, some of which are not covered herein.

To become an accomplished grader will require a thorough familiarity with the rules and then much practice. Graders are not "certified" to be able to grade lumber that will be sold under the NHLA rules. However, when graders are not proficient, a reinspection by a National NHLA grader can be requested, with various expenses being assessed to the loser of the reinspection.

Note that grading of hardwood lumber is always done in English units of measure. There is no metric measurement system available at this time.

---

[2]Virginia Lumber Manufacturers Association, P.O. Box U, Sandston, VA 23150 USA. Five disks for the IBM-PC (color) are available. In addition to the computerized lessons, 100 pieces of lumber are shown which must be measured and graded by the student.

Chapter 2 BOARD FOOT AND SURFACE MEASURE

Board Foot

The fundamental volume measurement unit of lumber is the board foot. A board foot is defined as a piece of lumber one foot wide, one foot long, and one inch thick (or volumetric equivalent). In practice, however, the board foot measurement is subject to wide variation. For example, a piece of lumber 11-5/8" wide, 12'0" long, and 3/4" thick is 12 board feet, just as a piece 12-3/8 wide, 12'11" long, and 1-3/16 inches thick is 12 board feet.

The formula for calculating the board footage (BF) of a piece of lumber is

$$BF = \left[\frac{\text{Length (ft.)} \times \text{Width (in.)}}{12}\right]_{\text{Round}} \times \text{Thickness}$$

or

$$BF = \left[\text{Length (ft.)} \times \text{Width (ft.)}\right]_{\text{Round}} \times \text{Thickness}$$

The value in parenthesis is the surface measure, SM, which will be critical in grading. The SM never has fractions; it is always rounded to the nearest whole number. When the value before rounding includes a fraction of 1/2, the SM is alternately rounded up and down (Para. 16).[3] Therefore, BF = SM x Thickness.

The following techniques apply to measuring lumber:

Length: Length is always measured in feet with the fractional length dropped (not rounded). The standard lengths (Para. 12) are 4', 5', 6', 7', 8', 9', 10', 11', 12', 13', 14', 15', and 16'. However, not over 50% of odd foot lengths will be permitted. An example of length measurement is provided in Table 1.

---

[3] The information in parenthesis means "paragraph 16," and refers to the appropriate paragraph in the NHLA Rules.

Table 1. Example of Length Measurement.

Actual Length	Standard Footage Length
10' 2"	10'
11' 3"	11'
11' 11"*	11'
3' 11"*	TOO SHORT
18' 2"	16'
10' 0"	10'

*One might question if these pieces are "properly manufactured," as required in Para. 8.

Width: Width is commonly measured in inches and fractions of an inch, with no rounding. Lumber that is not uniform in width, but is tapered from one end to the other, is measured at 1/3 of the length from the narrower end.

Thickness: For hardwoods, the thickness of a piece of lumber is the standard nominal thickness, rather than its actual thickness. It is typically found that 1-inch thick hardwood lumber, known as 4/4 (pronounced "four quarter"), is actually an average of 1-1/8 inches thick. Further, due to equipment variations and log characteristics, although the average is 1-1/8 inches, the thickness of any one piece and within a piece may typically vary 1/8-inch or more.

Standard thicknesses for rough lumber are given in Para. 13. The thicknesses include 4/4, 5/4, 6/4, 7/4, 8/4, and so on. The standard thickness (as a fraction) is used in the board foot calculation, although lumber thinner than 1 inch is considered to be 1-inch thick. (Note: The thickness is always measured at the thinnest point in the cutting used for grading [Para. 9]; this will be illustrated later in detail. This should make clear why thickness is measured after grading—in essence, the thickness of the lumber is the thickness of the cuttings used in grading. The part of the lumber not in the required cuttings may be scant in thickness.)

When lumber has varying thicknesses, the thickest and thinnest points within a cutting used to establish the grade are measured. If the variation is greater than indicated in Table 2, such lumber is called "miscut," but the grade is unchanged.

Table 2. Thickness Variation Permitted.

Rough Thickness	Maximum Variation
1/2" or less	1/8"
5/8" and 3/4"	3/16"
4/4" to 7/4"	1/4"
2" to 31/2"	3/8"
4" to 6"	5/8"

The following tabulation (Table 3) provides some examples of how standard thickness measurements are determined.

Table 3. Example of Thickness Measurement:

Actual Thickness	Standard Nominal Thickness
1-1/8"	4/4
1-3/16	4/4
1-7/16	5/4
1-15/16	7/4
2-7/16	8/4
2-9/16	10/4
1-1/8 to 1-3/8	4/4 (not miscut)
1-1/16 to 1-3/8	4/4 miscut
1-7/16 to 1-13/16	5/4 miscut
1-9/16 to 1-13/16	6/4 (not miscut)
2-1/8 to 2-7/16	8/4 (not miscut)

SM

SM is a measure of the area of a piece of lumber. Examples of the calculation of SM are given in Table 4. The units of measurement are square feet, but SM is just called "feet" or often left without units—i.e., the answer for the first example in Table 4 is "5 feet surface measure" or just "5 surface measure."

Table 4. Examples of SM Calculation.

Length	Width	SM
8' 4"	8"	(8 x 8 / 12 =) 5
8' 7"	12"	(8 x 12 / 12 =) 8
10' 3"	8-1/2"	(10 x 8.5 / 12 =) 7
10' 3"	8-1/4"	(10 x 8.25 / 12 =) 7

Exercise #1, pieces 1 through 10, should be completed at this point.

Lumber Rule Measurement of SM

In practice we find that the surface measure is almost always measured with a lumber rule or stick (Figure 1) that already has the results of multiplication of length times width and the correct rounding of the answer indicated on it.

The lumber rule (Figure 1) is a quick method of determining the SM. The rule has a metal end that has a flange with two sharp pointed ends. This permits the stick to be used to flip the lumber so both sides of the lumber can be examined. The broader part of the flange is sharpened so that it can be used to scrape a spot on the lumber, thereby giving a better view of potential defects. The metal end also has a "go - - no go" gauge for measuring thickness. This thickness feature is discussed in the next section.

Immediately below the flange are the numbers "12, 10, 14, 16" on one side and "9, 11, 13, 15" on the other. These numbers refer to the length of the piece being measured.

To measure the SM, rule is then placed across the width of the lumber, the edge of the flange on one edge (Figure 2), with the correct side of the rule (corresponding to the lumber's length) facing upward. Using the correct length column (Figure 3), the SM is read where the other edge (the opposite edge) of the lumber crosses under the rule. It can be a little tricky at first to figure which number to use, so pay particular attention to the diagram and the examples, especially for the 12' lengths.

Note that the 12 foot column is possibly confusing—for all the other columns the number is within the box it represents, while the 12 foot column doesn't have boxes. The boxes should be the 1/2" marks. When using this column, it is necessary to remember to round the numbers, as needed—for example, a width of 7-3/8" is rounded to 7. In all cases, when the width is exactly at the dividing point between two SM, round up and down alternately on each piece.

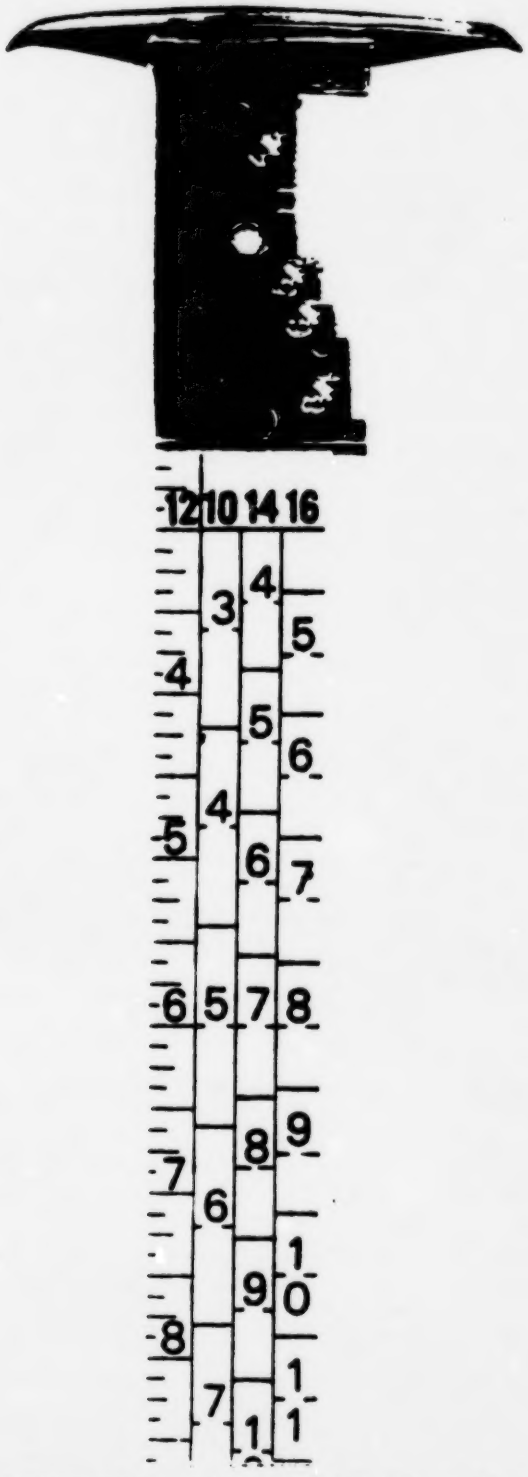


Figure 1 A lumber grading stick, with the side for even length lumber showing.

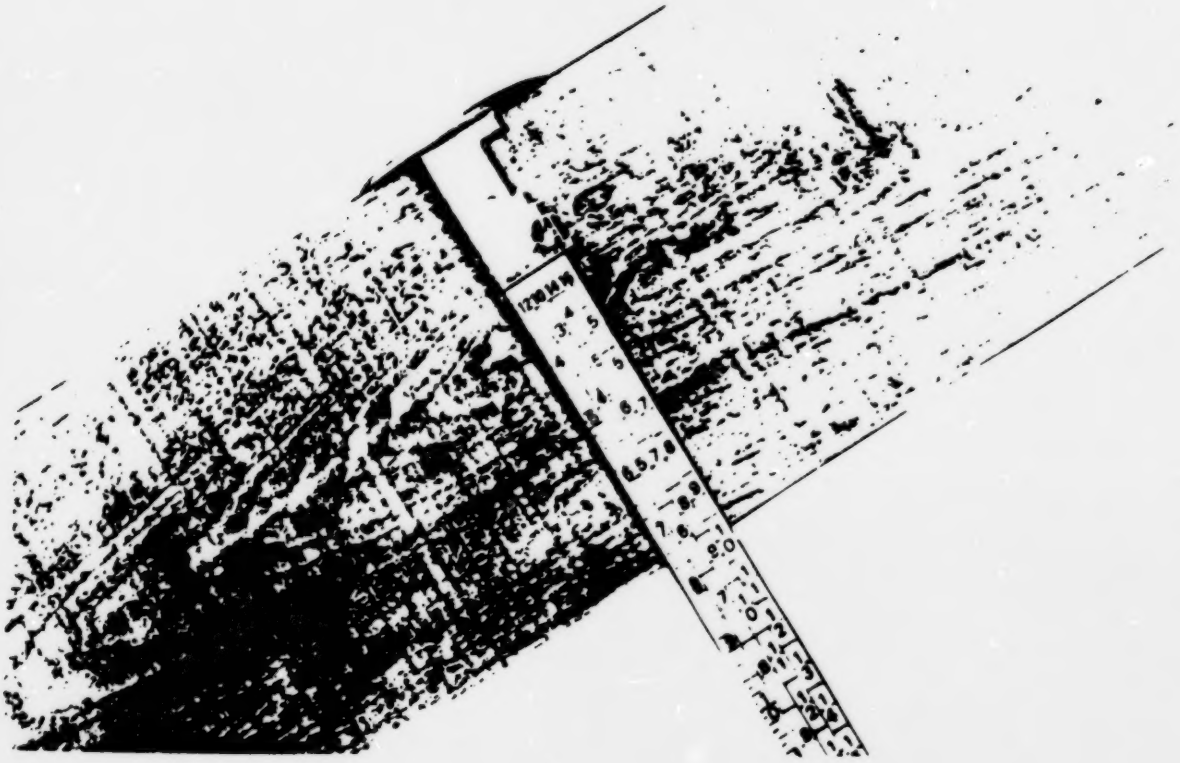


Figure 2 A lumber grading stick in use on a piece of lumber 7-3/8" wide, with the side for even length lumber showing.

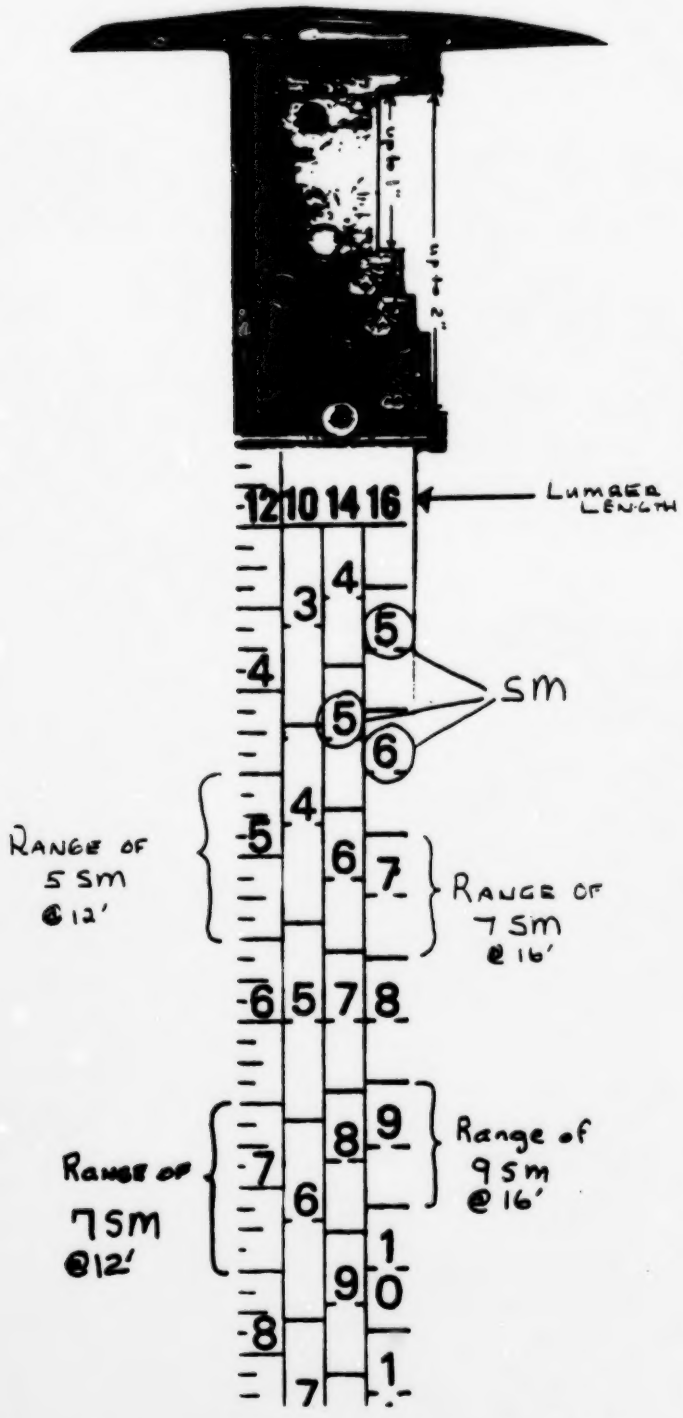


Figure 3 A lumber grading stick with the SM regions and thickness gauge illustrated, with the side for even length lumber showing.

Referring to Figure 4, the following SM's are obtained for a piece of lumber that is 7-3/8" wide (Table 5).

Table 5. The SM's for Even Length Lumber, 7-3/8" Wide.

Lumber Length	SM
10'	6
12'	7
14'	9
16'	10

The reverse side of the grading stick is used for odd length lumber. Continuing with the 7-3/8" wide piece of lumber, mark 7-3/8" on the stick with your thumb. Then turn the stick over, moving your thumb to the other side, but keeping it 7-3/8" from the flanged end. The following SM's are obtained (Table 6).

Table 6. The SM's for Odd Length Lumber, 7-3/8" Wide.

Lumber Length	SM
9'	6
11'	7
13'	8
15'	9

Exercise #1, pieces 11 through 20,using the lumber rule, and Exercise #2 should be completed now.

For 5' through 8' lumber lengths, the 10', 12', 14', or 16' scale is used and the answer is divided in half. For 4' lumber lengths, the 16' scale is used and divided by 4. The number from the measuring stick must consider the fractional reading before dividing, so that the answer is correctly rounded.

Here is an easy way to do the correct rounding for 4' to 8' lumber when the quotient contains a fraction of 1/2. Ask whether the piece of lumber when measured on the longer length scale is on the narrower side ("skinny") or on the wider side ("fat") for the indicated SM value. For example, consider 8' lumber that measures 7 foot SM on the 16' scale. When 7 is divided in half to convert the 16' scale to

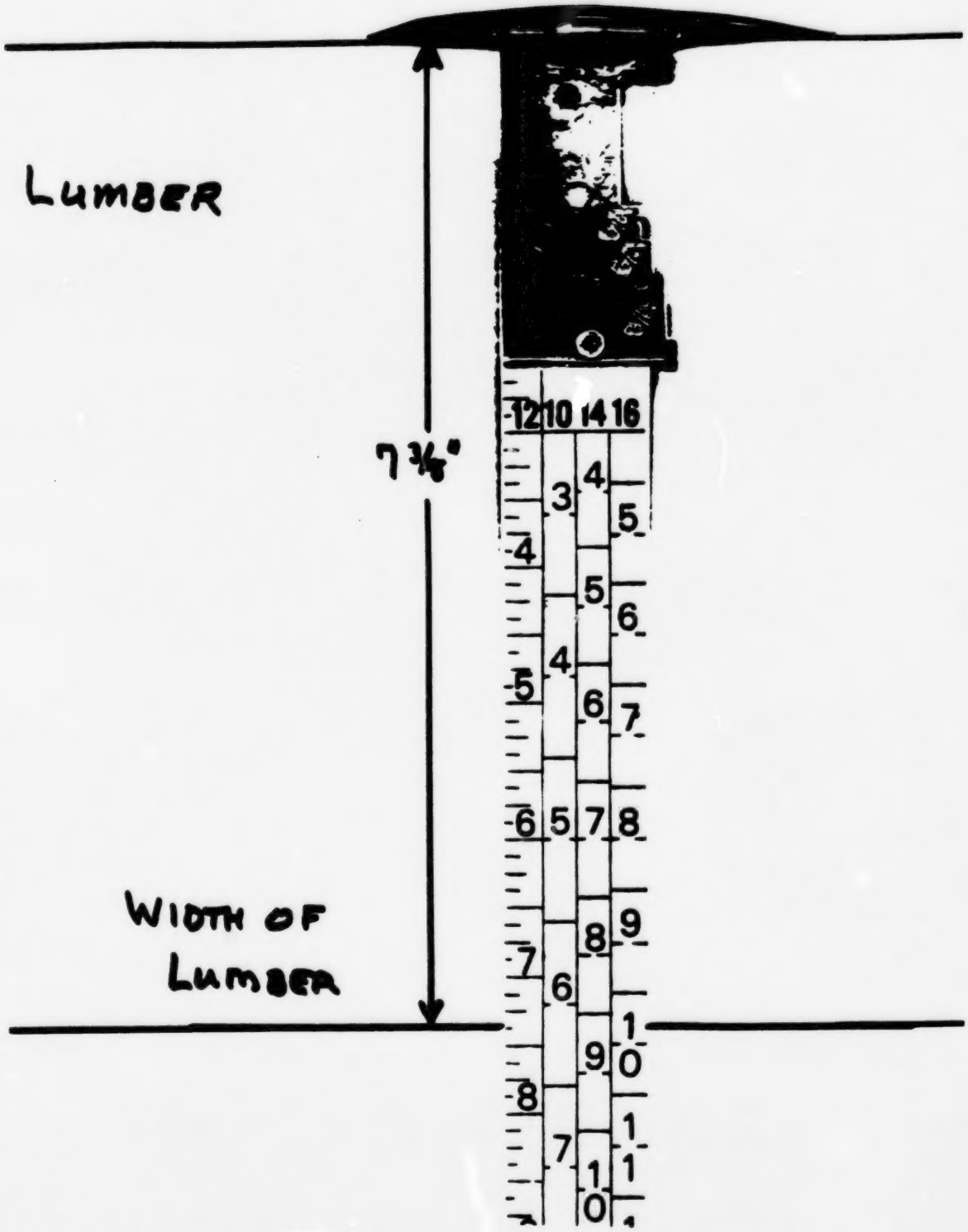


Figure 4 A close-up view of a scaling stick in use with lumber 7-3/8" wide.

8' lumber, the answer is 3-1/2. Should this be reported as 3' or 4' SM? If the piece is wide or fat for the 7' measurment—values wider than the marks on each side of the 7—then the answer is 4' SM. If the width is under the marks adjacent to 7, then the SM is 3. This is illustrated in Figure 5.

Continuing with the 7-3/8" wide piece, the SM for 4' through 8' lumber is given in Table 7.

Table 7. The SM's for Short Lumber, 7-3/8" Wide.

Lumber Length	SM
4'	2
5'	3
6'	4
7'	4
8'	5

Exercise #3 should be completed now.

Board Footage Calculation

It is standard practice to calculate the footage by summing first the SM for all pieces of a given grade (or other grouping) and nominal thickness, and only then multiplying by the thickness (Para. 18).

Examples of board footage calculations are:

4/4 No.1 Common lumber; SM = 3216 surface feet;
BF = (3216 x 4/4) = 3216 board feet.

5/4 No.1 Common lumber; SM = 3216 surface feet;
BF = (3216 x 5/4) = 4020 board feet.

In other words, the board footage is not measured and tallied for each piece individually. For that reason, we always measure the SM, then grade the piece, and then finally measure the thickness.

Exercise #4 should be completed at this point.

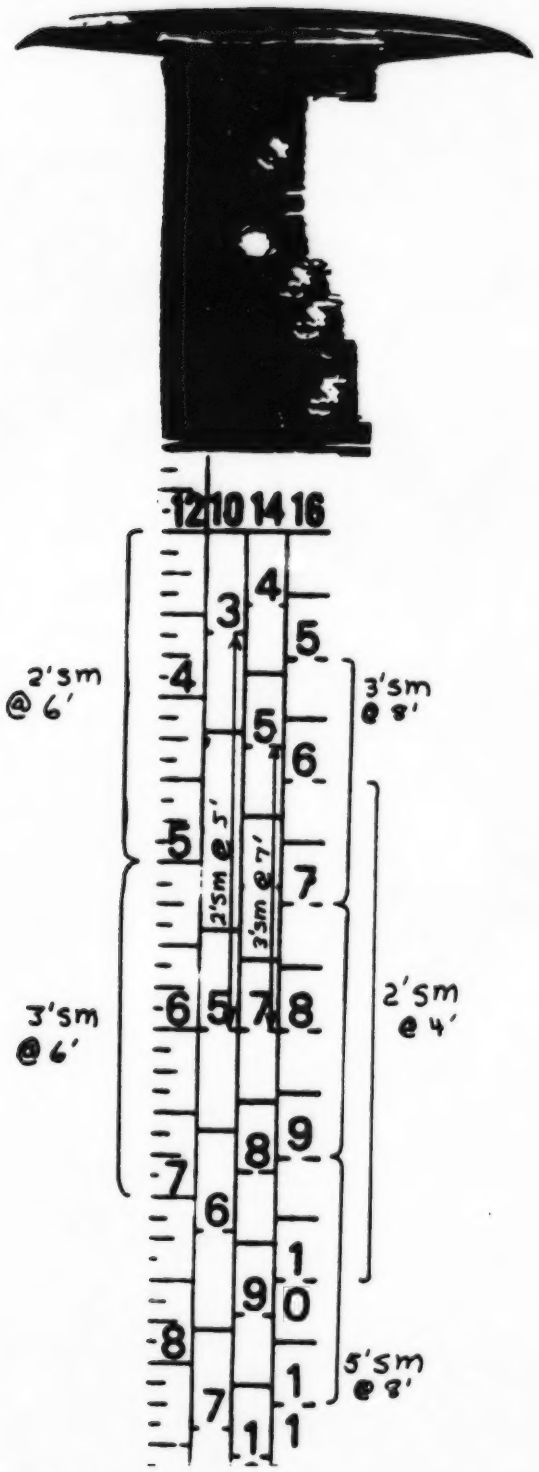


Figure 5 The dividing point for short lumber.

Chapter 3 CUTTINGS

Cuttings and cutting units

The underlying basis for grading hardwood lumber is its expected usefulness in a furniture, cabinet, or millwork plant. Therefore, the various grades will reflect the area of the lumber that is clear or free from defects or blemishes affecting the lumber's usefulness. These areas used for establishing the grade are called cuttings. Their area is measured in cutting units. One cutting unit is rectangular area 1" wide and 1'long (or equivalent). In other words, a cutting unit is the area in square inches divided by 12. For example, for a perfectly clear piece of lumber 10" wide and 12' long, the SM is 10 and the piece contains 120 cutting units.

When grading, the lumber will be mentally divided into cuttings. For the upper grades, these cuttings must be clear on one face (free of knots, stain, and so on (accept aspen admits stain), as well as be free of rot, pith, shake, and wane throughout (not just on the face). The reverse face of the cutting can contain sound knots and certain other defects as we'll see. Note that the piece of lumber can have rot, pith, shake, and wane, but the lumber cannot. The maximum number of cuttings and their minimum size is specified in the grading rules for each grade. The cuttings must be rectangular and run parallel to the lumber's length—diagonal cuttings are not permitted. The cuttings can be positioned so that in reality it might take a jig saw to cut them out. Further, no kerf allowance is made. As an example, the piece of lumber illustrated in Figure 6 has been divided into 3 and 4 clear-face cuttings.

Frequently, the cuttings will be fractional lengths and widths. For example, 3' 9" long and 5-1/4"wide. To determine the cutting units, the length should first be converted to feet (i.e., 3'9" = 3-3/4 feet). Then, multiply 3-3/4 x 5-1/4 to obtain the answer of 19-11/16 cutting units. Recall that fractions are easily multiplied by multiplying the parts individually and then summing (Table 8).

Table 8. Multiplication of Fractions. (Each part is multiplied by the other two parts individually and then summed.)

3-3/4 x 5-1/4 =

3 x 5 = 15
3 x 1/4 = 3/4
3/4 x 5 = 15/4 = 3-3/4
3/4 x 1/4 = 3/16

15 + 3/4 + 3-3/4 + 3/16 = 19-11/16

Exercise #5 should be completed at this point.

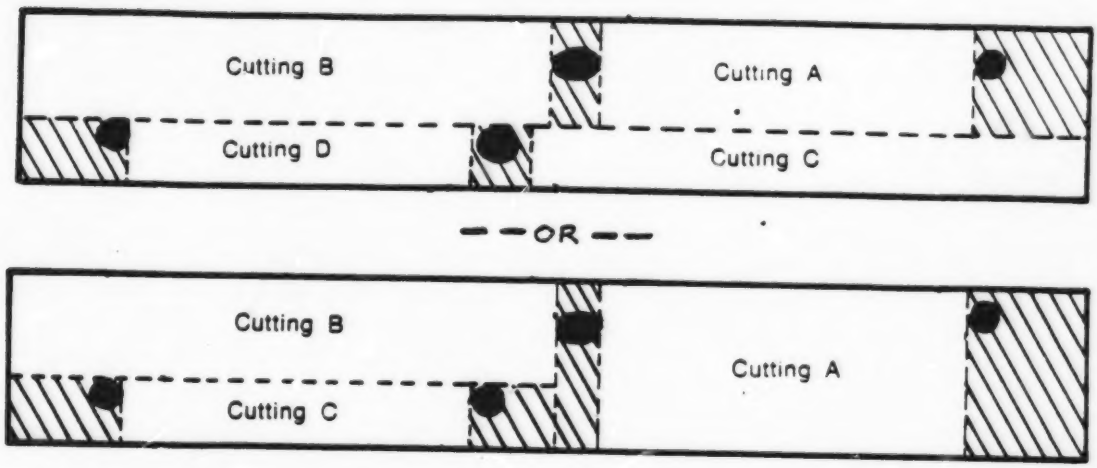


Figure 6 Lumber is divided into clear cuttings. This shows two possible divisions.

Clear Face Cutting

The basis of many grades of hardwood lumber is the size of the clear areas. To obtain this area, clear-face cuttings are used. A clear-face cutting is a cutting that is free of defects on the face (Para. 30)—knots, rot, pith, shake, wane, and stain. Ordinary seasoning checks are acceptable. Ordinary seasoning checks are small cracks in the surface of the lumber which will be eliminated in planing--they do not affect the usefulness of the lumber. Mineral streaks are also acceptable. Note that a distinction is made between stain (which would be fungal in origin in most cases) and mineral (which in the broadest interpretation would be chemical in origin). Experience is the best guide to the difference between stain and mineral. The reverse side of the clear cutting must be sound. (Note: Burls with sound centers, swirly grain, or cross grain are not defects.)

Sound Cutting

A sound cutting is a cutting that is free of rot, pith, shake, and wane. Sound knots (knots without a soft center or knots not containing bark), bird pecks, stain, streaks or their equivalent not affecting the strength, and small holes are admitted in sound cuttings (Para. 31). The idea of a "sound" hole is difficult to imagine, but holes can be sound.

Any defects in lumber which could be removed by surfacing to the standard thickness are not considered for clear-face and sound cuttings. That is, a small shallow spot of bark, shallow wane, shallow stain and so on can be overlooked if they will surface out—the thicker the lumber over its standard thickness, the more that can be surfaced out.

Exercise 6 should be completed at this time, laying out the cuttings and calculating their cutting units. These pieces will be graded later.

Overlength

The standard lengths are integer lengths in feet (without fractions or inches). A piece 8' 3" long is considered to be 8' long. It therefore has 3" of overlength. Defects (knots, splits, wane, pith) in the overlength (the overlength can be divided between each end or be considered to be all on one end) can be overlooked with respect to size. However, the clear-face or sound cuttings can extend into the clear or sound area of the overlength if appropriate (i.e., the area is clear or sound) and if desired.

Knot and Hole Sizes; Size of Splits

Knot and hole sizes are measured by measuring the maximum length and minimum width and then averaging the two values. This is illustrated in Figure 7. Splits are measured linearly. However, the length of the split in the overlength is not counted.

Definitions

The rule book is the final authority on the definitions. The student should have the following terms well defined and should understand their meanings before proceeding further:

Ordinary seasoning checks

Sound cutting

Clear-face cutting

Rot

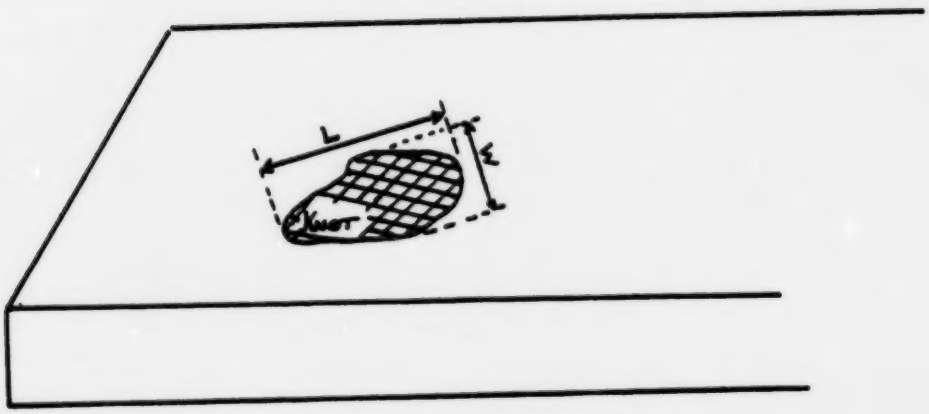
Pith

Shake

Wane

Knot, sound

Knot, unsound



DIAMETER = L x W/2

Figure 7 Knots or holes are measured for size by averaging the smallest and largest dimensions.

Chapter 4 STEPS IN GRADING

The hardwood lumber grades commonly used today are (Figure 8):

First and Seconds (FAS)

Selects (including "FAS One Face (F1F)")

No.1 Common (also called "Commons")

No.2 Common (Some species use No.2A and 2B Common)

No.3A Common

No.3B Common

There are other standard grades, such as "sound wormy," and many special grades each with special rules. For example, sometimes 3A and 3B Common are combined into No.3 Common, which incidentally must include all the 3A Common produced. In addition many species have special rules, often governing lumber size and the effect of stain. For example, birch allows more short pieces in FAS and Select; aspen allows stain in the clear cuttings; and so on. This is discussed in more detail in Lesson 9.

The following ten steps (Table 9) are the steps that must be followed when grading lumber. In all cases, the lumber must be graded "as is." A grader cannot base the grade on future trimming or edging--sometimes called "pencil trimming." Of course, a grader on the green chain of a sawmill could indicate that a piece should be trimmed or edged before it is graded, and then, after remanufacturing, have the piece return for grading.

All lumber must be graded full length, width, and thickness.

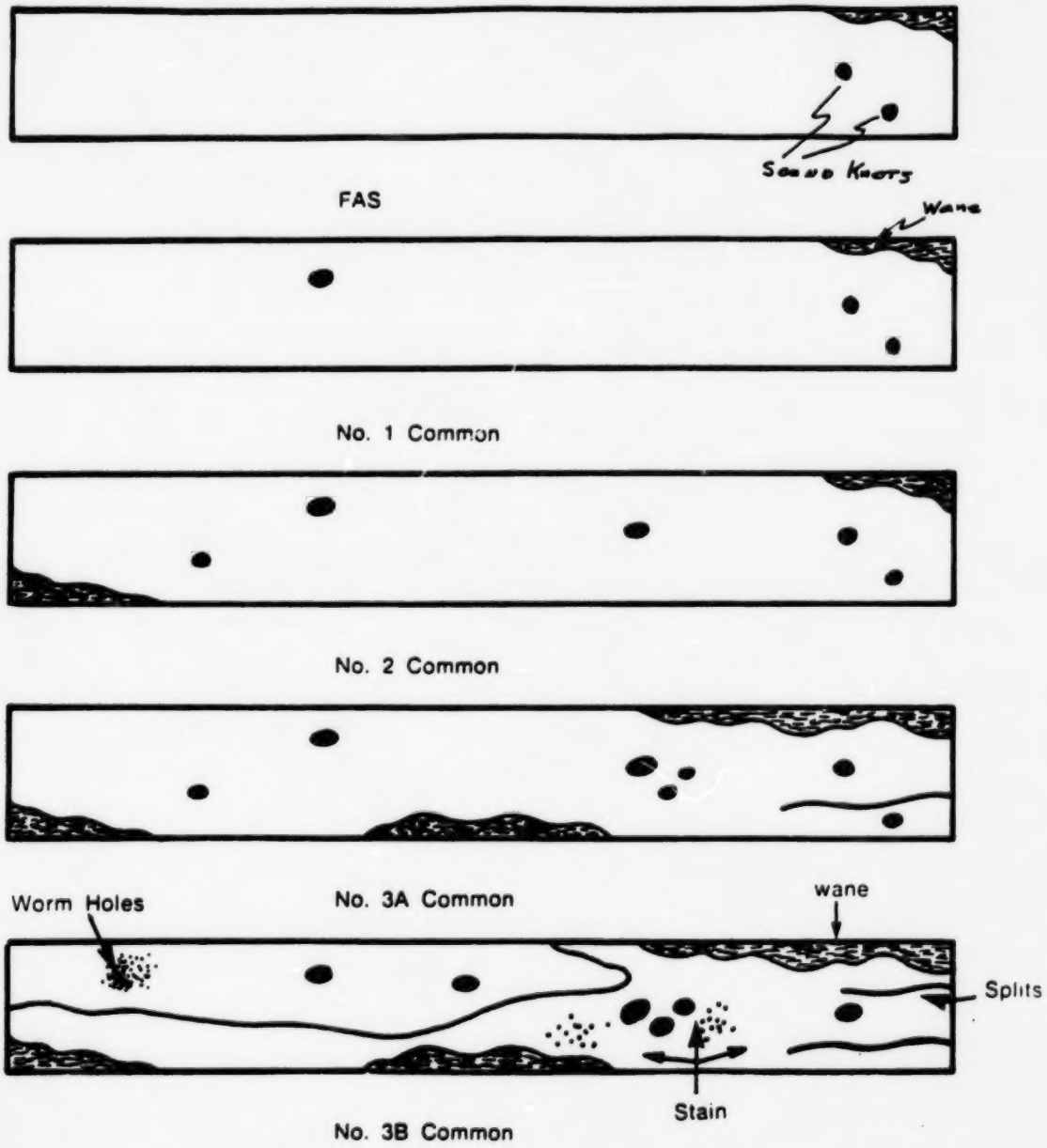


Figure 8 Typical pieces of lumber for several of the standard hardwood lumber grades. Shown is the grading face.

Table 9. The Ten Steps for Grading Hardwood Lumber.

STEP 1.	Determine the species
STEP 2.	Determine the SM
STEP 3.	Determine the grading face.
STEP 4.	Assume the best potential grade, including size, wane, etc.
STEP 5.	Determine the number of cuttings permitted for the assumed grade and the known SM.
STEP 6.	Determine the number of cutting units needed for the assumed grade.
STEP 7.	Lay out the cuttings.
STEP 8.	Determine the number of cutting units available.
STEP 9.	If the available cutting units does not exceed the number required, try the next lower grade.
STEP 10.	Tally grade and SM. Note: It is at this point that thickness is measured.

Chapter 5 FAS RULES (Para. 53-64)[4]

FAS Lumber Size

For lumber to make the FAS grade, a piece must be at least 8-feet long. It must also be at least 6 inches wide, although a few pieces can be up to 1/4" scant in width (Para. 10). (Note: For certain species--yellow-poplar, cherry, walnut, etc.--there is a requirement for the percentage of heartwood.)

FAS Cuttings

The cuttings must be clear-face cuttings which means they must be sound on the reverse. The cuttings must be at least 4" wide and 5' long. Cuttings from 3" up to 4" wide can be used if they are at least 7' long. The clear-face cuttings are laid out on the poorer face of the lumber--i.e., FAS is graded from the poorer side.

The maximum number of cuttings allowed is SM/4 (but not over four) with any fractions dropped. For example, a piece of lumber 10-5/8" wide by 12' has an SM of 11. The number of cuttings allowed is 11/4 or 2.

The required minimum number of cutting units is 10 SM. This is approximately 10/12 or 83-1/3% of the lumber's surface area. It is stated as "approximately" because SM and surface area are not perfectly aligned because of rounding when calculating SM and because of overlength.) For example, the required number of cutting units for SM = 11 is 110. All clear-face cuttings are considered from the poorer side of lumber—that is, FAS is graded from the poorer side.

With pieces of lumber with SM of 6' to 15', it is possible to use one additional cutting (that is, SM/4 + 1), but when this is done, the minimum number of cutting units is 11 SM. (With the extra cutting, more of the lumber must be clear.) For example, if SM 13, then the maximum number of cuttings permitted is 4 with 143 required cutting units.

An additional option, called the 97% Rule, applies to SM of 6 to 12. This rule permits two cuttings, any length and full width (No wane!) that yield 11.64 SM (97%). This is shown in Figure 9. [Note: Ninety-seven percent of an 8 feet (96 inch) piece is 93 inches. So essentially the 97% Rule means a one small defective area around 3" long (plus any overlength)—and proportionally larger for longer lumber.]

---

[4] A summary of the rules is given on the back page of this booklet.

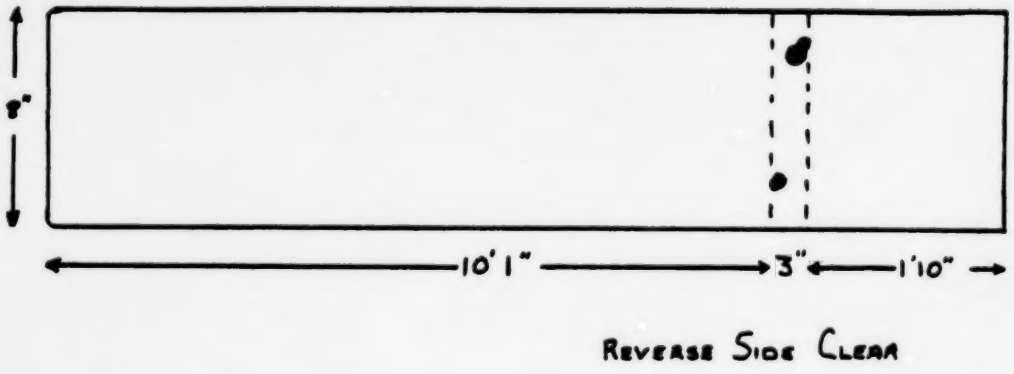


Figure 9 The 97% rule permits two clear-face cuttings of any length, full width that total 11.64 SM.

Other FAS Requirements

There are several other requirements for FAS:

A. Pith in the piece cannot exceed (in aggregate) SM inches. (Example: If SM = 8, then the pith—visible on the surface or inside the piece—cannot exceed 8 inches.) (Note Figure 10.)

B. Wane cannot exceed 12 SM (units of square inches) in area. (For example, if SM = 11, then the maximum wane area is 132 square inches. In addition, wane cannot exceed 1/2 the length of the piece on either edge. (For example, with a piece 12'3" long, the maximum wane length is 6' plus 3" more if the wane is in the overlength.) Remember with all defects, if they will be removed in surfacing to standard thickness they can be ignored. (Note Figure 11.)

C. The length of splits in aggregate cannot exceed 2SM (units in inches), except 12" or shorter splits are not measured for length when the end foot rule applies (See F below). Splits longer than 12 inches can diverge no more than 1" per foot. The length of splits in the overlength is not included. (Note Figure 12.)

D. The average diameter of any knot or hole cannot exceed 1/3 SM (units in inches). (Example: If SM = 11, then the maximum knot size is 11/3 inches.) Refer to Figure 7 for how to measure a knot.

E. Warp cannot be too severe to prevent surfacing to standard thickness, with an exception for 12" and wider pieces (Para. 61).

F. END FOOT RULE. Within one lineal foot of each end, there must be at least 50% clear (two pieces, any shape). In addition, there cannot be more than 25% unsound wood. (See Figure 13.)

(Recall: Defects that can be removed in surfacing to standard thickness or defects in the overlength are disregarded.)

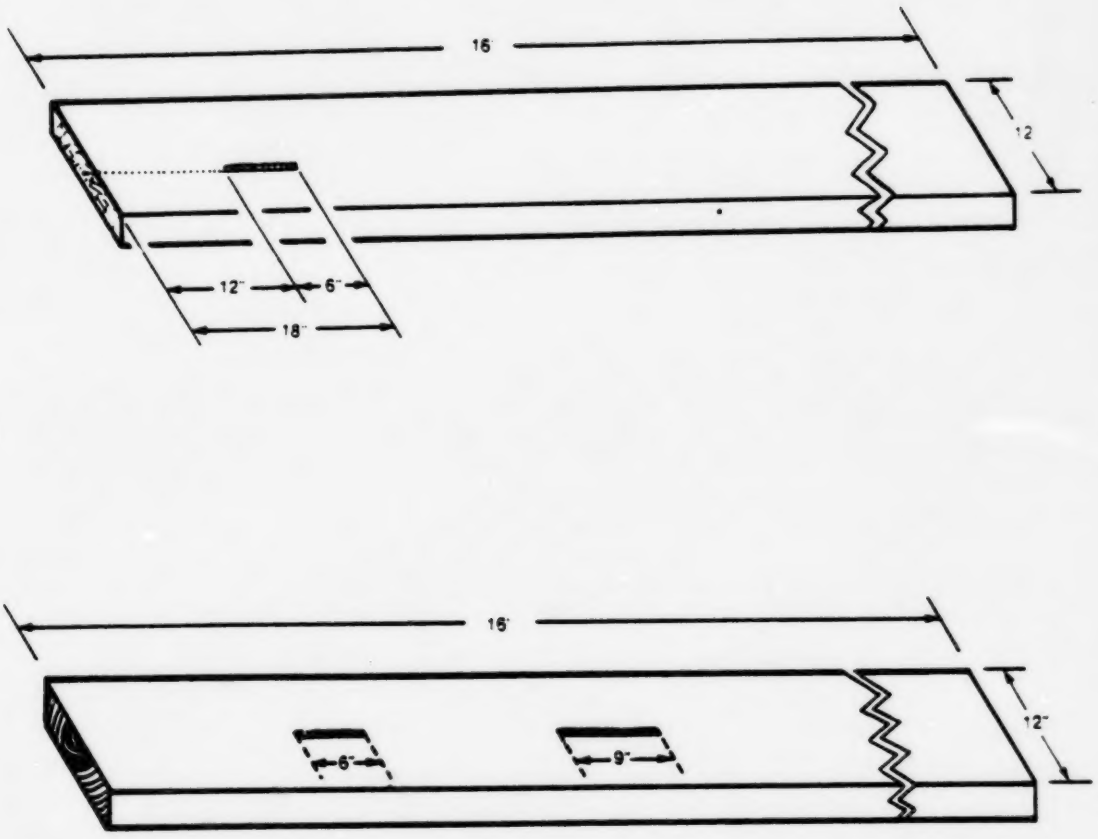


Figure 10 Pith is limited in FAS. In the first example, the pith is inside the lumber for the first 12" and then is on the surface for 6". Total pith is 18", which exceeds the allowable of 16" (numerically equal the SM, but units are inches). In the second example, the pith is only on the surface for 6" and then 9", for 15" total, which does not exceed 16".

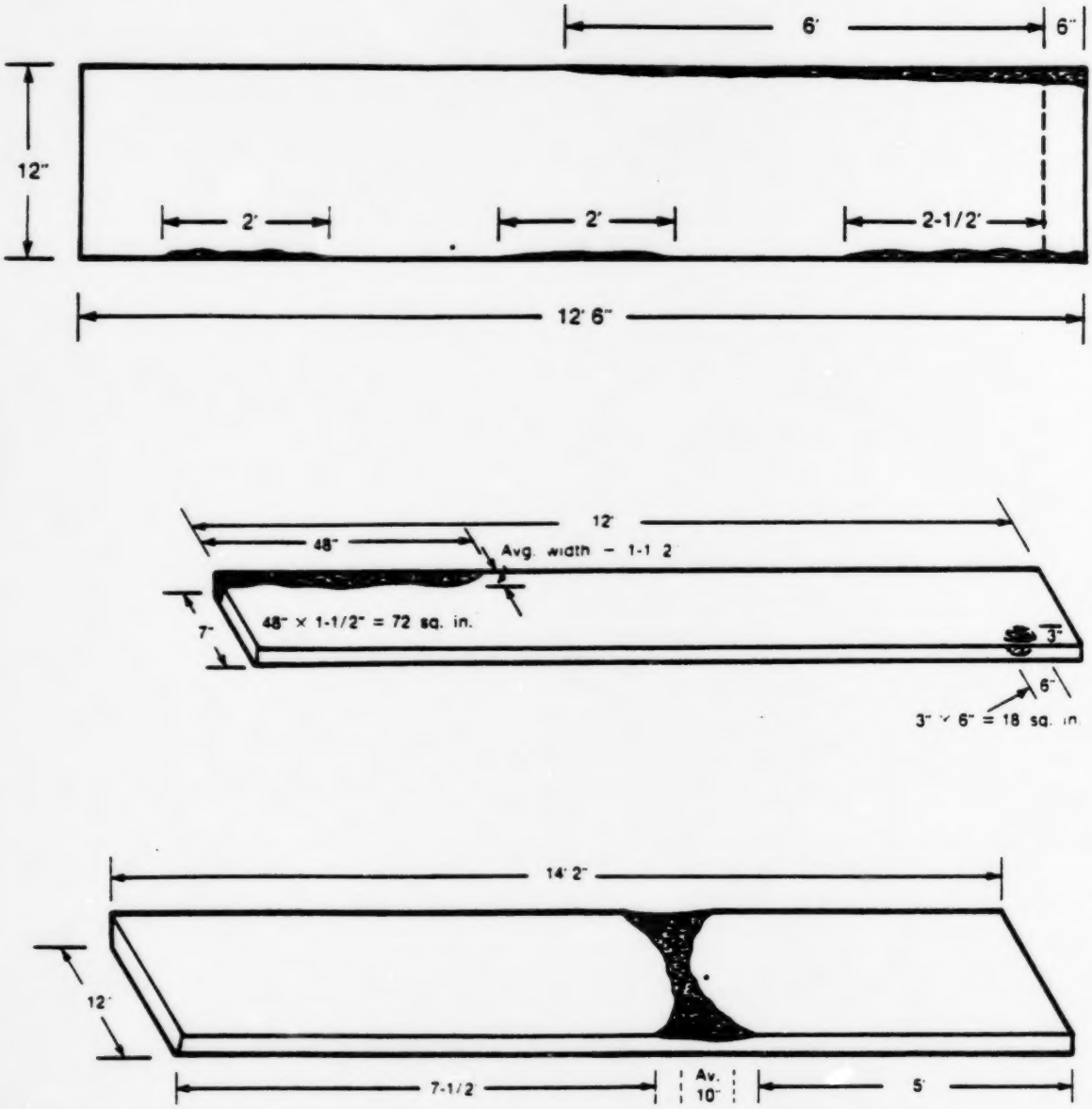


Figure 11 Wane rule illustrations for FAS.

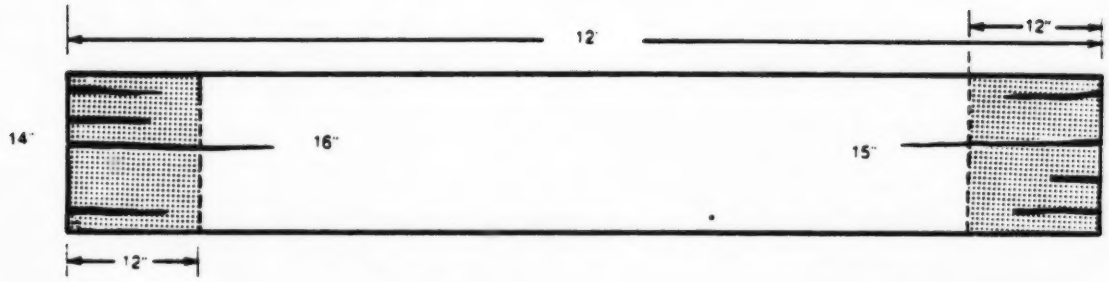


Figure 12 Length of splits over 12" long are limited in FAS. The length of splits here is 16 + 15 = 31". Short splits are not considered in this calculation. Any overlength is subtracted from the total length.

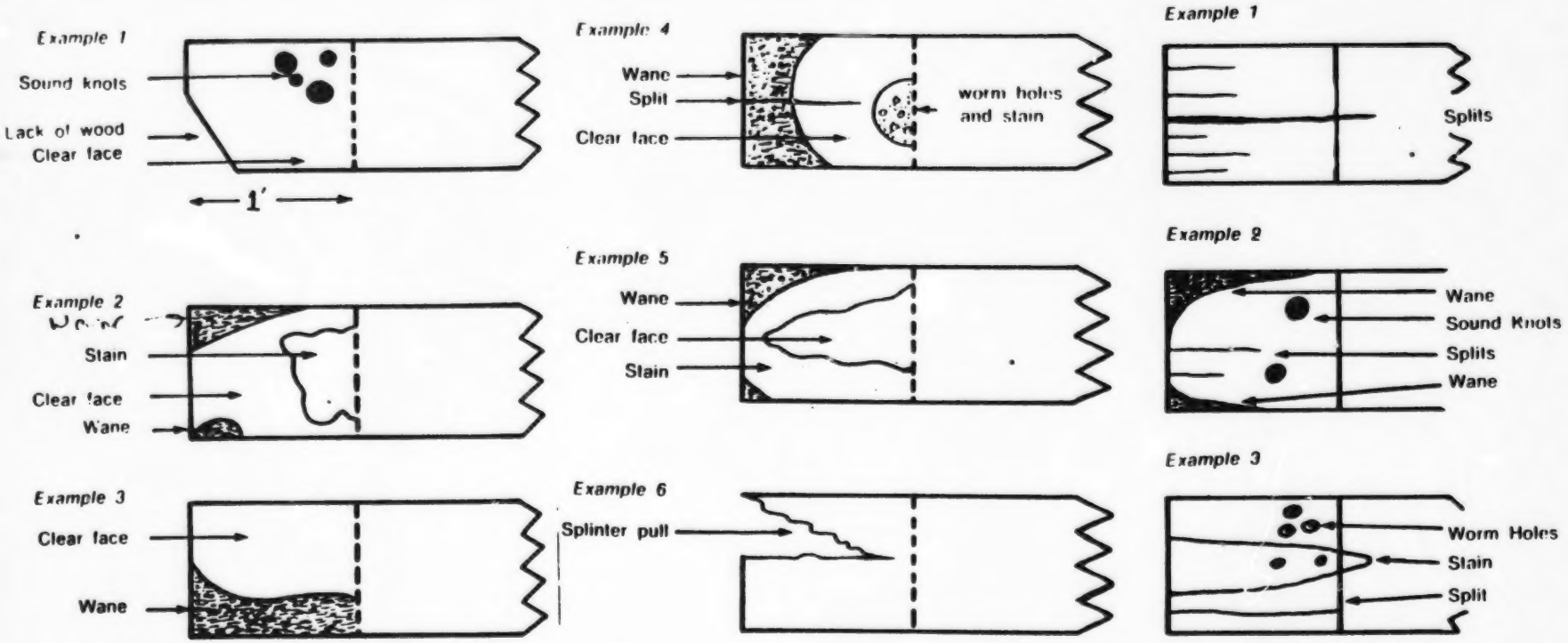


Figure 13 The end foot rule in FAS. Examples 3, 4, and 5 fail the requirements for FAS end foot being 50% clear and not more then 25% unsound. For aspen, Example 5 is acceptable, as stain is not a defect.

Chapter 6 NO.1 COMMON RULES (Para. 71 - 75)

Lumber Size

For lumber to be graded as No.1 Common (also called "Common lumber"), a piece must be 3 inches or wider and 4' to 16' long. There are limits on the number of narrow and short pieces (Para. 71 & 72).

Cutting Size and Number

The minimum size clear-face cutting is 4" x 2', or if 3" up to 4" wide, then 3' long. The maximum number of cuttings permitted is (SM + 1)/3 up to a maximum of 5, with any fractions being dropped. For example, if the SM = 10, then the maximum number of cuttings is (10 + 1)/3 (= 3-2/3) = 3. The cuttings are measured on the poorer face.

The required number of clear-face cutting units is 8SM. For example, with SM = 10, the required units are 8 x 10 = 80. Note two special cases: For pieces of SM = 1, the piece of lumber must be clear on both faces. For SM = 2, the required number of clear-face cutting units is 9SM.

An extra cutting can be used for SM's from 3 to 10 inclusive; that is, the maximum number of cuttings is [(SM + 1)/3] + 1. When the extra cutting is used, then the cutting units required increases to 9SM.

Note: The cutting units required yields of 8SM and 9SM are approximately 2/3 and 3/4 of the lumber's surface area. (It is stated as "approximately" because SM and surface area are not perfectly aligned because of rounding when calculating SM and because of overlength.)

Pith may not exceed 1/2 the length (scaling length) of the piece; as usual, pith also cannot be in the cuttings, as specified for clear-face/ reverse side sound cuttings.

As always, there are special considerations for the overlength and for defects that will "surface out."

Note that No.1 Common does not have any requirements for knot size, wane, splits, holes, and so on required for FAS, other than that the piece must be well manufactured.

Chapter 7 SELECT RULES (Para. 65 - 70)

Select lumber is often considered to be the hardest lumber to grade correctly due to the complexity of the wane rules. There are two types of Select lumber—Sound Back Selects, which grade FAS on the good face and the reverse side of the cuttings are sound; and Common Back Selects, which require FAS on the good face and the reverse side grading No.1 Common or better with the FAS and No.1 Common cuttings not required to be sound on the reverse.

Lumber Size

For lumber to graded Select, it must be 4" or wider. It must be 6' to 16' long, with restrictions on the shorter pieces (Para. 66).

FAS Side

The FAS side shall be the better side. All the requirements for FAS (Para. 55 through 61) apply to the FAS side, including the cutting size, cutting yield, and wane.

Pieces of SM = 2 and SM = 3, must yield 11SM in one clear-face cutting on the good side, with the reverse sound or No.1 Common.

Wane

Wane for 4" and 5" wide pieces can have wane on one edge not over 1/3 the width and 1/2 the length in aggregate or divided between two edges.

Wane for 6" and wider, SM = 4' or more cannot have wane on the No.1 Common side exceeding 1/4 the width and 3/4 the length (or 1/3 the width and 1/2 the length) in aggregate. The width may be divided and be on both edges. (Note: This means that wane, as shown in Figure 11, would be unacceptable on the No.1 Common side, as the wane extends more than 1/4 (or 1/3) across the width. Likewise, the wane in Figure 13, Examples 2, 3, 4, 5, 6, and 8 is too wide for the No.1 Common face. Such wane could be acceptable on the FAS face, however.)

Chapter 8 NO.2, 3A, AND 3B COMMON RULES (Para. 76 - 87)

No.2 Common Lumber Size

For lumber to be graded as No.2 Common, a piece must be 3 inches or wider and 4' to 16' long. There are limits on the number of short pieces (Para. 77).

No.2 Common Cutting Sizes and Numbers

The minimum size clear-face cutting is 3" x 2'. The maximum number of cuttings permitted is SM/2, with any fractions being dropped, up to a maximum of 7, . For example, if the SM = 9, then the maximum number of cuttings is 9/2 (= 4-1/2) = 4. The required number of clear-face cutting units is 6SM. For example, with SM = 9, the required units are 6 x 9 = 54. (Note that for pieces of SM = 1, the piece of lumber must have one clear face cutting yielding 8SM.) The cuttings are determined from the poorer face.

An extra cutting can be used for SM's from 2 to 7 inclusive; that is, the number of cuttings is (SM/2) + 1. When the extra cutting is used, then the cutting units required increases to 8SM.

Note: The cutting units required of 6SM and 8SM are approximately 1/2 and 2/3 of the lumber's surface area. (It is stated as "approximately" because SM and surface area are not perfectly aligned because of rounding when calculating SM and because of overlength.)

Pith is not restricted, except in the cuttings, as required in clear face/sound cuttings.

As always, there are special considerations for the overlength and for defects that will "surface out."

No.3A Common Lumber Size

For lumber to be graded as No.3A Common, a piece must be 3 inches or wider and 4' to 16' long. There are limits on the number of short pieces (Para. 83).

No.3A Common Cutting Sizes and Numbers

The minimum size clear-face cutting is 3" x 2'. The maximum number of cuttings permitted is unlimited. The required number of clear-face cutting units is 4SM. For example, with SM = 9, the required units are 4 x 9 = 36. The cuttings are determined from the poorer face.

Note: The cutting units required of 4SM is approximately 1/3 of the lumber's surface area. (It is stated as "approximately" because

SM and surface area are not perfectly aligned because of rounding when calculating SM and because of overlength.)

Pith is not restricted, except in the cuttings, as required in clear face/sound cuttings.

As always, there are special considerations for the overlength and for defects that will "surface out."

Also, pieces of lumber that grade No.2 Common or higher on the better face are graded as No.3A Common.

No.3B Common Lumber Size

For lumber to be graded as No.3B Common, a piece must be 3 inches or wider and 4' to 16' long. There are limits on the number of short pieces (Para. 86).

No.3B Common Cutting Sizes and Numbers

The minimum size sound cutting is 1-1/2"wide and at least 36 square inches. The maximum number of cuttings permitted is unlimited. The required number of clear-face cutting units is 3SM. For example, with SM = 9, the required units are 3 x 9 = 27. The cuttings are determined from the poorer face.

Note: The cutting units required of 3SM is approximately 1/4 of the lumber's surface area. (It is stated as "approximately" because SM and surface area are not perfectly aligned because of rounding when calculating SM and because of overlength.)

Pith is not restricted, except in the cuttings, as required in sound cuttings.

As always, there are special considerations for the overlength and for defects that will "surface out."

Chapter 9 F1F ("ONE FACE") RULES[5]

One face grade is quite popular in the eastern furniture trade. All of the lumber in this grade can be classified as Select (but not all Select is One Face). This grade requires one side of the lumber to be FAS and the other to be No.1 Common (or better). Therefore, the size of the lumber must be FAS sizes; all other FAS requirements must also be met.

There are special wane rules for the No.1 Common side: Wane cannot exceed 1/3 the width. Wane cannot exceed 1/2 the length in aggregate on either edge.

The cuttings on either side do not have to be sound on the reverse.

---

[5] See "Special Inspection", p.47 in 1986 edition.

Chapter 10 SPECIES VARIATIONS

Birch

A larger percentage of shorter pieces are admitted in FAS and Select grades.

Aspen

Stain is admitted in all grades of lumber.

No.2 and No.3A Common require sound cuttings, not clear cuttings.

Chapter 11 GRADING PRACTICE AND QUIZ

Practice in grading is the best way to become a proficient grader. To begin, grade the pieces shown in Exercise #6, remembering to use the 10 steps of grading. Then continue with Exercise #7. Assume that the species is birch.

The following format should be used when learning to grade, using Example 6A:

Step 1—Species: Birch

Step 2—SM: 5

Step 3—Grading Face: A

Step 4—Assumed Grade: FAS

Step 5—No. of Cuttings Permitted: 1

Step 6—No. of Cutting Units Required: 50

Step 7—Lay Out Cuttings

Step 8—Cutting Units Available: 40

Step 9—Not enough cutting units for FAS; Try No.1 Common
(Repeat Step 4 - 8)

Step 4—Assumed Grade: No.1 C

Step 5—No. Cuttings Permitted: 2

Step 6—No. of Cutting Units Required: 40

Step 7—Layout cuttings

Step 8—Cutting Units Available: 59

Step 9—Not Applicable (this time); check other side however to see if it is FAS, following Steps 3 through 8 again. The B face is FAS.

Step 10—Tally and Grade: 5' Select (Common Back)

Once proficiency with the rules is obtained, complete the following quiz. If possible, write the answers without referring to this booklet or your notes. A certificate of completion can be obtained by sending the quiz and the application form to Virginia Tech.

Quiz

1. Define the following terms in one or two sentences.

   a. Cutting

   b. Cutting unit

   c. Clear-face cutting

   d. Sound cutting

   e. Surface Measure

   f. Board Measure

   g. Wane

   h. Split

i. Decay

j. Rot

k. Shake

l. Miscut 4/4

m. Miscut 8/4

n. Sound knot

o. Unsound knot

p. Stain

q. Mineral

r. Pith

s. Ordinary seasoning check

2. Complete the following chart using the standard yield and number of cuttings.

Grade	Cutting Yield	Number of Cuttings	Minimum Size of Cutting	Minimum Size of Lumber
FAS				
Sel (Common Back)				
No.1				
No.2				
No.3A				
No.3B				

3. How much pith and wane are permitted in No.1 Common lumber?

How much pith and wane are permitted in No.2 Common lumber?

How much pith and wane is permitted in sound and clear-face cuttings?

NAME _____
(Please print clearly or type)

I have carefully studied the grading rules for hardwood lumber, have studied this tutorial, have attended a grading class or completed the Virginia Tech computerized tutorial, and have completed the quiz (which is attached).

Signed _____

Company:

Mailing Address:

Mail this request with a copy of the quiz to:

Eugene M. Wengert
Brooks Forest Products Center
Virginia Tech
Blacksburg, VA 24061-0508

Chapter 12 EXERCISES AND ANSWERS

Exercise #1.

Complete the following chart using paper and pencil to calculate the SM and BF for the first 10 pieces and using a grading stick for the next 10. For the BF calculation, assume 100 identical pieces.

#	Width	Length	Thickness	Standard Length	Standard Nominal Thickness	SM	BF
	(inches)		(inches)				
1	7-1/2	8'10"	1-1/8				
2	6-3/8	12' 8"	2-3/16				
3	10-3/4	15'11"	1-3/8				
4	8	10' 2"	1-1/8				
5	8	10' 3"	3/4				
6	9-1/4	12' 2"	1-5/8				
7	8-1/2	5' 3"	1-1/8				
8	10-3/8	12' 3"	2-1/8				
9	10-1/4	14' 2"	1-1/32				
10	6-1/4	8'3"	1-1/8				
11	5-3/4	10' 3"	1-1/8				
12	7-7/16	12' 6"	1-1/8				
13	7-9/16	12' 6"	1-1/8				
14	8-7/16	12' 6"	1-1/8				
15	4-1/8	16' 0"	1-1/8				
16	5-7/8	16' 5"	1-7/8				
17	10-3/4	16' 3"	2-1/8				
18	10-3/4	16' 0"	2-1/8				
19	10-3/4	16' 11"	2-1/8				
20	4	14' 5"	1-1/8				

*Assume 100 identical pieces.

Exercise #2

Based on Figure 14, calculate the SM for all the lengths.

Lumber Width	12'	10'	14'	16'
1				
2				
3				
4				
5				

Based on Figure 15, calculate the SM for all the lengths.

Lumber Width	9'	11'	13'	15'
6				
7				
8				
9				
10				

Exercise #3

Based on Figure 14, calculate the SM for all the lengths.

Lumber Width	4'	5'	6'	7'	8'
1					
2					
3					
4					
5					

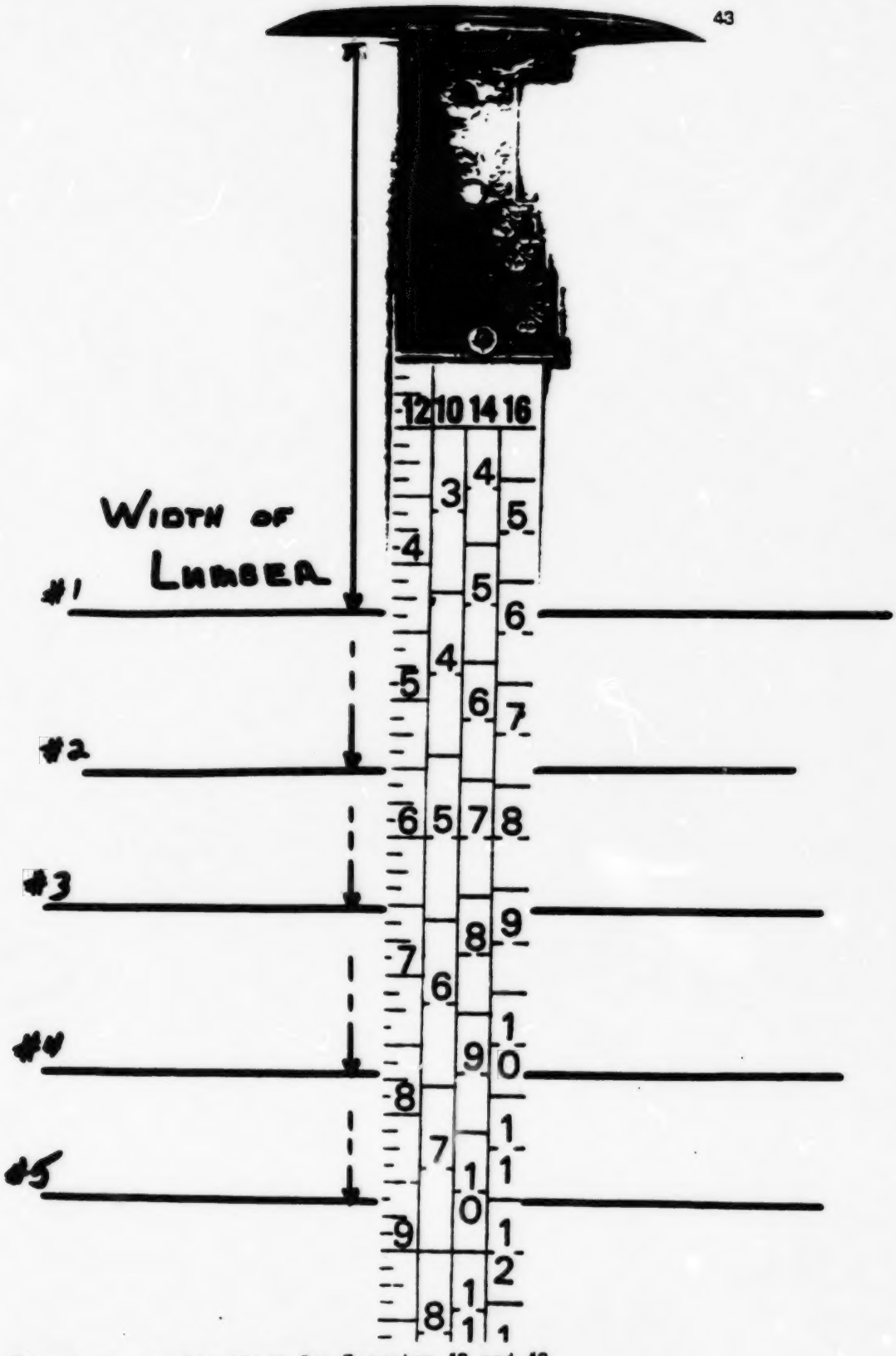


Figure 14 - Lumber sizes for Exercise #2 and #3.

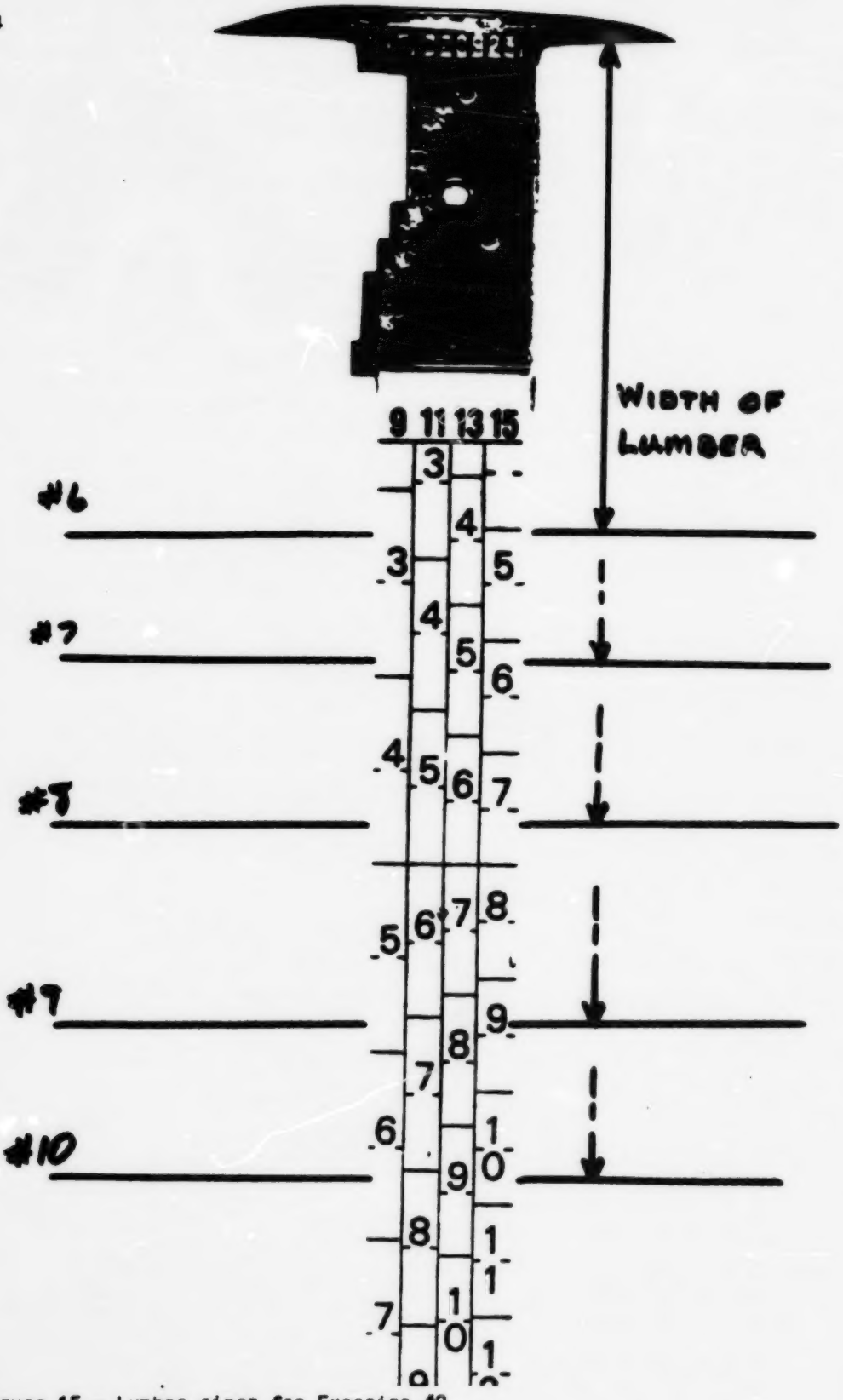


Figure 15 - Lumber sizes for Exercise #2.

Exercise #4

Calculate the board footage for the indicated SM and lumber thickness.

SM = 600 ft, No.1 Common

BF(4/4) =

BF(5/4) =

BF(6/4) =

BF(8/4) =

SM = 800 ft, No.2 Common

BF(4/4) =

BF(5/4) =

BF(6/4) =

BF(8/4) =

SM = 900 ft, No.3 Common

BF(4/4) =

BF(5/4) =

BF(6/4) =

BF(8/4) =

SM = 1200 ft, No.1 Common and Better

BF(4/4) =

BF(5/4) =

BF(6/4) =

BF(8/4) =

Exercise #5

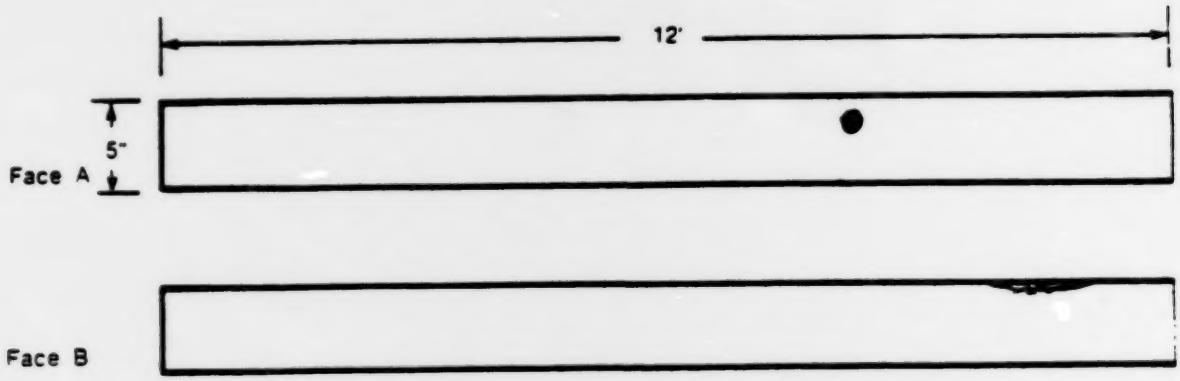
Multiply the following fractions, using first an approximate answer, ignoring the small fraction times a small fraction. Then obtain the exact answer. In many cases it will not be necessary to achieve an exact answer when grading.

	Approximate	Exact
1. 3-3/4 x 4-1/6 =		
2. 4 x 5-1/4 =		
3. 4-1/2 x 8-1/3 =		
4. 5-1/4 x 6'6" =		
5. 5-3/8 x 7'3" =		
6. 5-1/4 x 4-1/3 =		
7. 3-3/4 x 5-1/12 =		
8. 4-3/8 x 3'9" =		
9. 5-1/8 x 10 =		
10. 5-1/2 x 8-1/3 =		

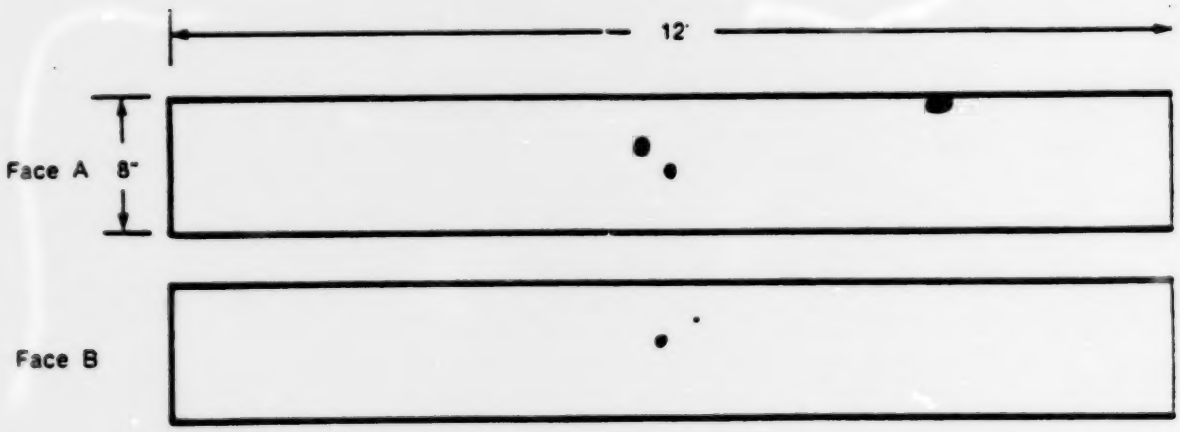
Exercise #6.

Layout large cuttings on the following pieces of lumber. Use cuttings at least 3" wide and 3' long. Calculate their area in cutting units. These pieces will be graded later, so save the cutting information.

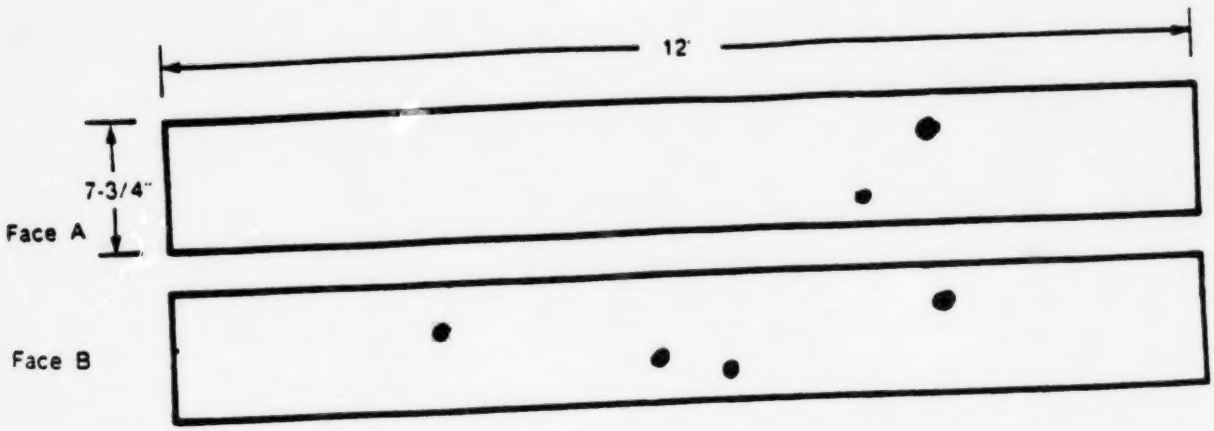
Lumber #6A.



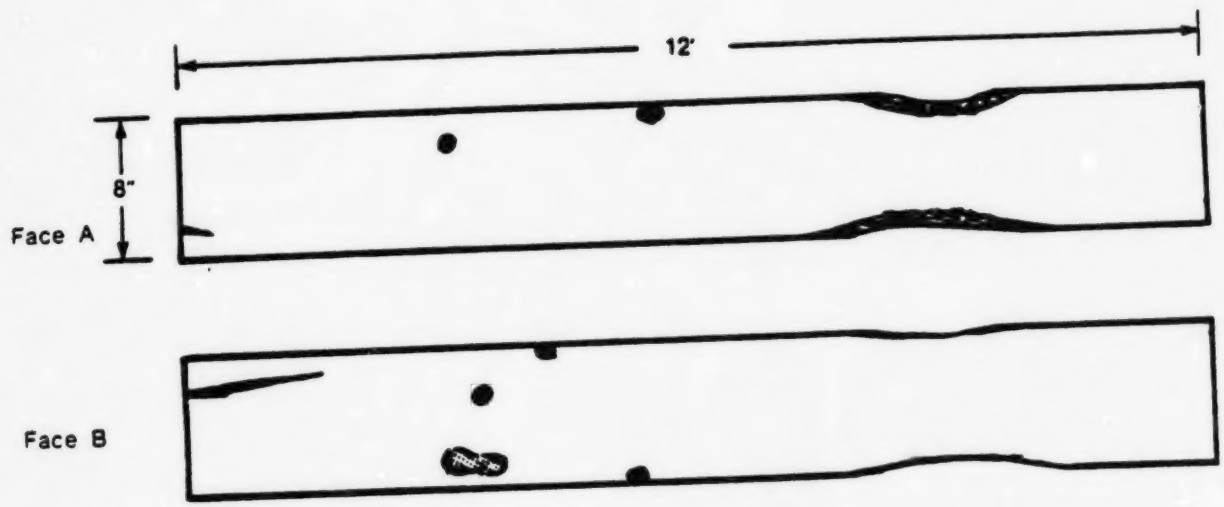
Lumber #6B



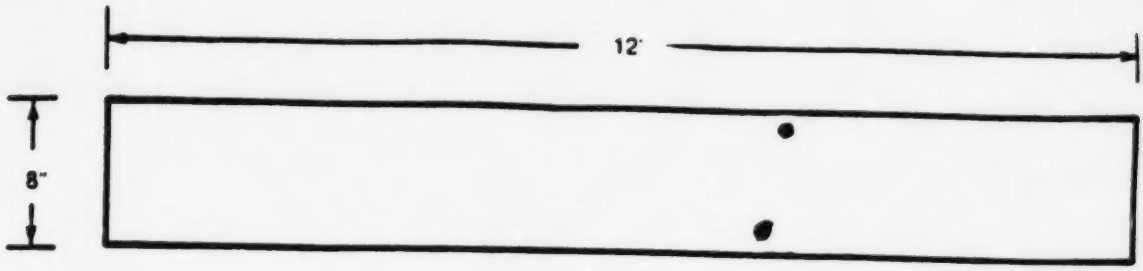
Lumber #6C



Lumber # 6D

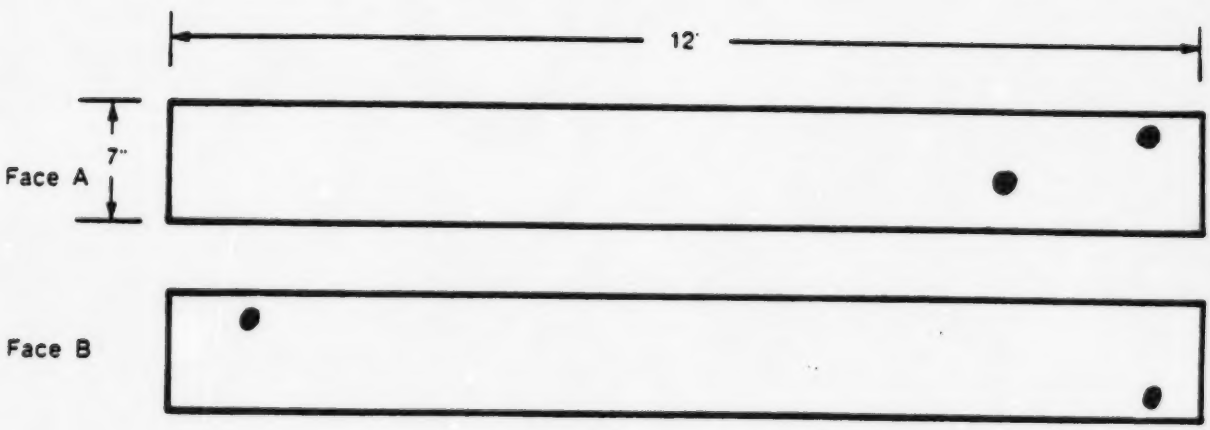


Lumber #6E



REVERSE IS CLEAR.

Lumber #6F

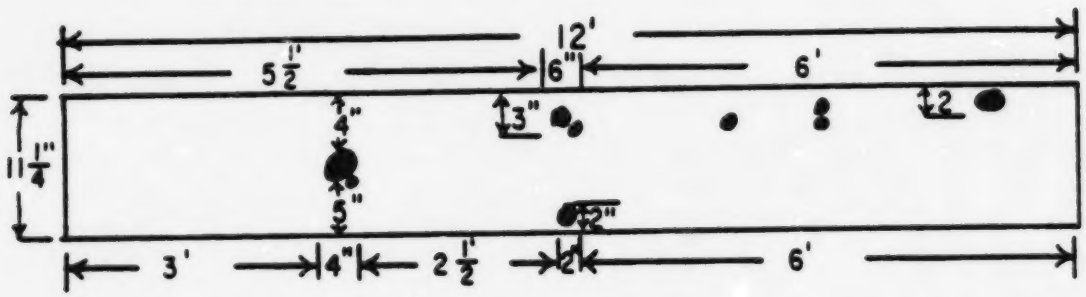


Exercise #7

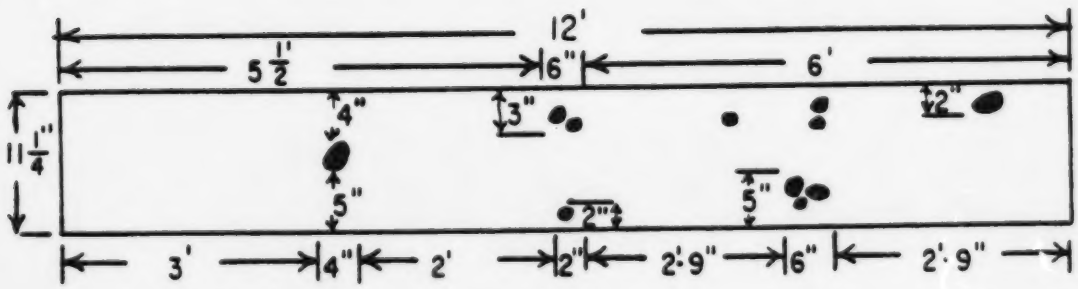
Grade the following pieces of lumber.

Lumber #7A

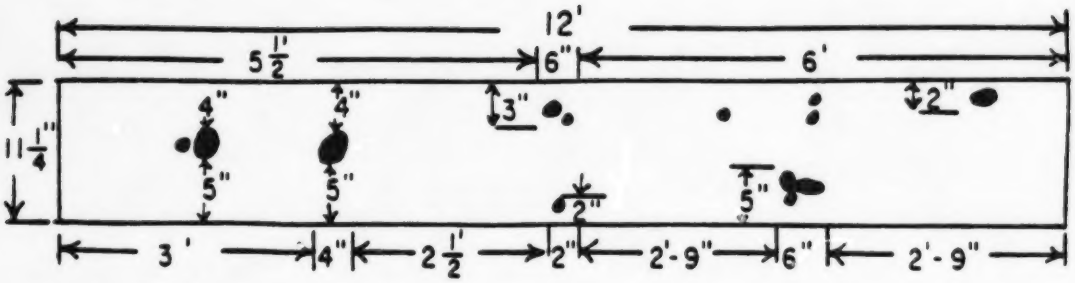
Lumber #7B



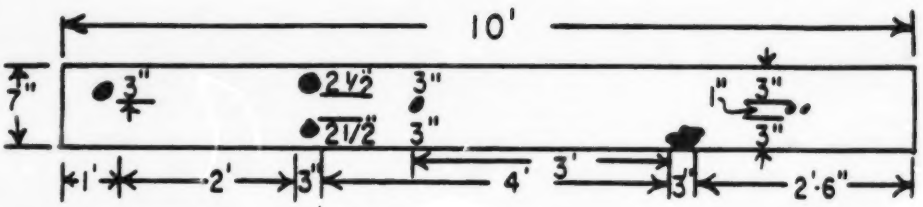
Lumber #7C



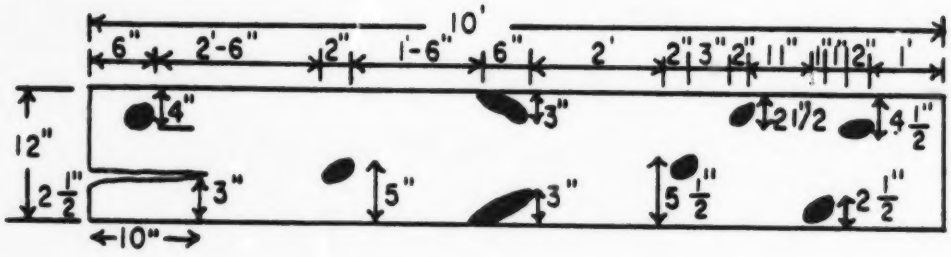
Lumber #7D



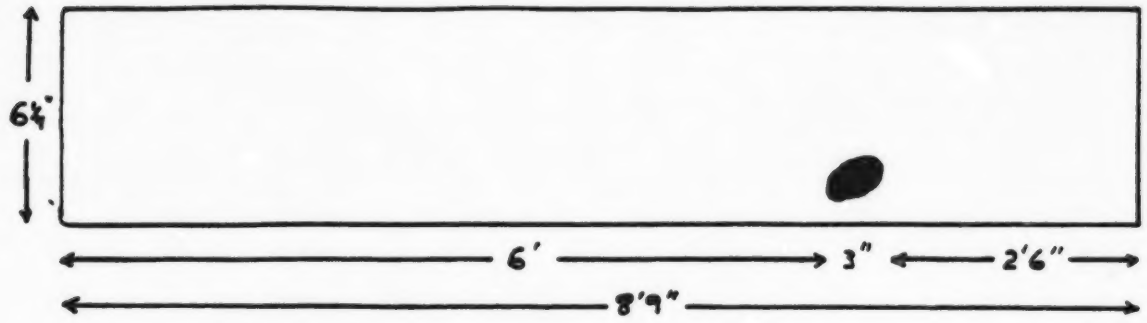
Lumber #7E



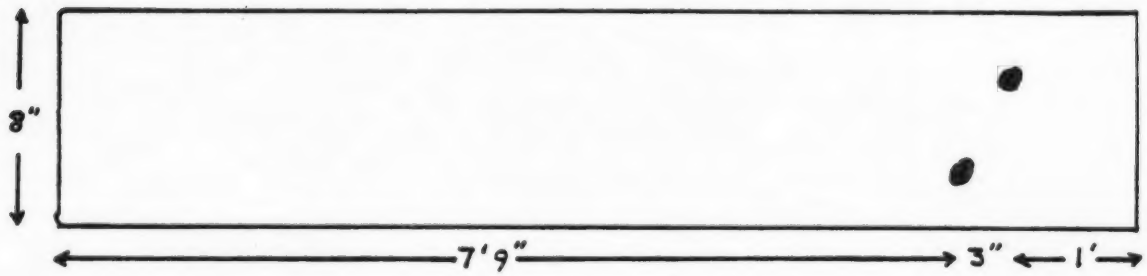
Lumber #7F



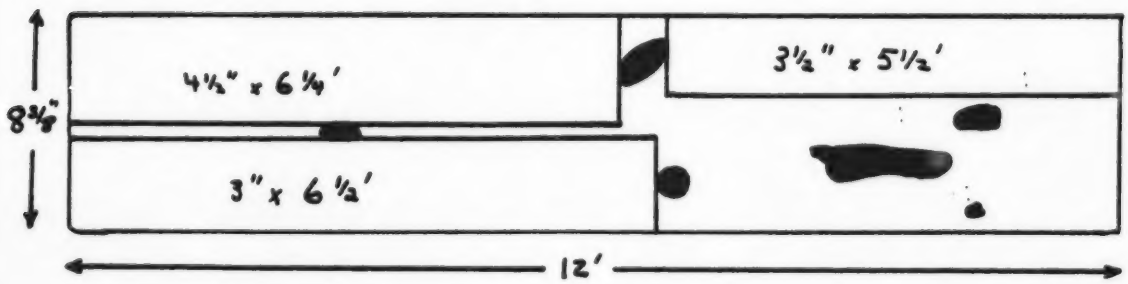
Lumber # 7G



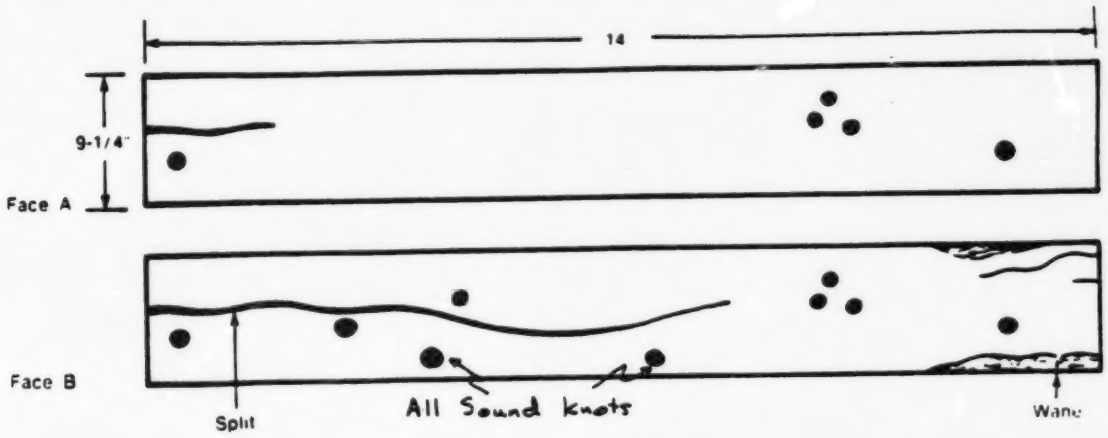
Lumber #7H



Lumber #7I



Lumber #7J



Answers for Exercise #1

#	Standard Length	Standard Nominal Thickness	SM	BF
1	8	4/4	5	500
2	12	8/4	6	1200
3	15	5/4	13	1625
4	10	4/4	7	700
5	10	4/4	7	700
6	12	6/4	9	1350
7	5	4/4	4	400
8	12	8/4	10	2000
9	14	4/4	12	1200
10	8	4/4	4	400
11	10	4/4	5	500
12	12	4/4	7	700
13	12	4/4	8	800
14	12	4/4	8	800
15	16	4/4	5 or 6	550
16	16	4/4	8	800
17	16	8/4	14	2800
18	16	8/4	14	2800
19	16	8/4	14	2800
20	14	4/4	5	500

Answers for Exercise #2; Based on Figure 14.

Lumber Width	12'	10'	14'	16'
1	4	4	5	6
2	6	5	6	7
3	7	5	8	9
4	8	6	9	10
5	9	7	10	12

Based on Figure 15.

Lumber Width	9'	11'	13'	15'
6	3	3	4	5
7	3	4	5	6
8	4	5	6	7
9	5	7	8	9
10	6	8	9	10

Answers for Exercise #3; Based on Figure 14.

Lumber Width	4'	5'	6'	7'	8'
1	1	2	2	3	3
2	2	2	3	3	4
3	2	3	3	4	4
4	3	3	4	5	5
5	3	4	4	5	6

Answers for Exercise #4.

SM =	600	800	900	1200
BF(4/4)	600	800	900	1200
BF(5/4)	750	1000	1125	1500
BF(6/4)	900	1200	1350	1800
BF(8/4)	1200	1600	1800	2400

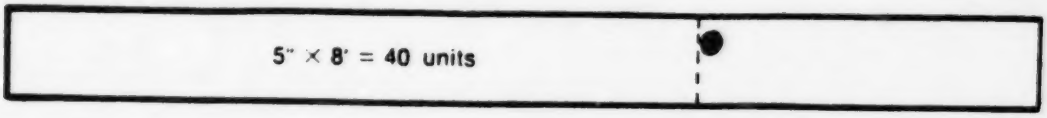
Answers for Exercise #5.

#	Approximate	Exact
1	15 plus	15-15/24
2	21	21
3	37 plus	37-1/2
4	34 plus	34-1/8
5	38 plus	38-31/32
6	22 plus	22-3/4
7	19 plus	19-3/48
8	16 plus	16-13/32
9	51 plus	51-1/4
10	46 minus	45-5/6

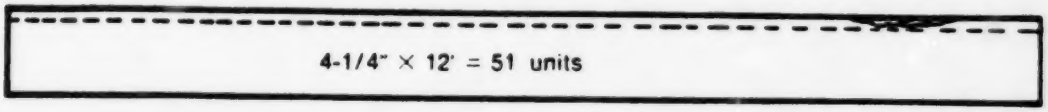
Answers for Exercise #6

Lumber #6A—5' of Select (Common Back or Sound Back)

Face A

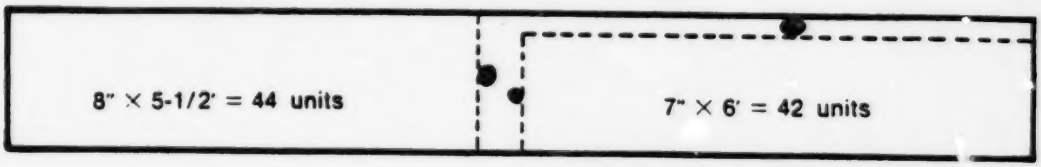


Face B



Lumber #6B—8' FAS

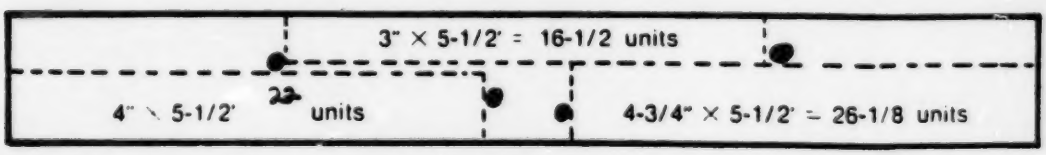
Face A



Lumber #6C—8' No.1 Common

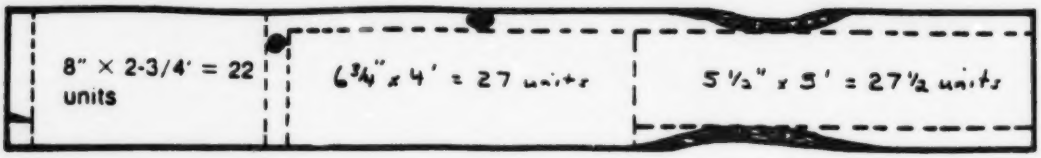
Face A

Face B

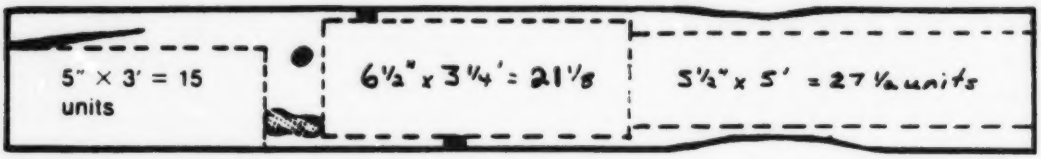


Lumber # 6D—8' No.2 Common

Face A



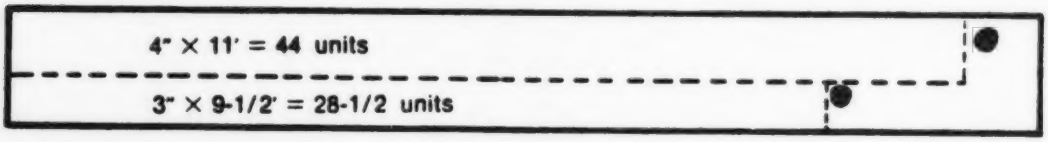
Face B



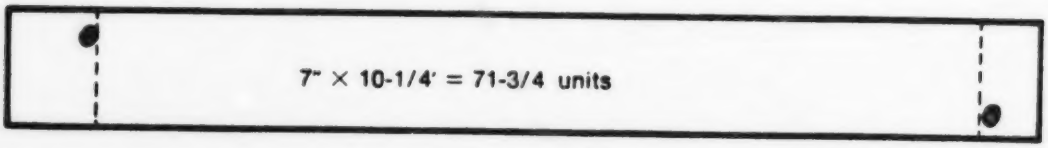
Lumber #6E—8' FAS (97% Rule)

Lumber #6F—7' Select (Common Back or Sound Back)

Face A



Face B



Answers for Exercise #7.

#	SM	Grade
A	10'	FAS
B	11'	No.1 Common
C	11'	No.1 Common
D	11'	No.1 Common
E	6'	No.2 Common
F	10'	No.3A Common
G	4'	No.1 Common
H	6'	FAS
I	8'	No.1 Common
J	11'	No.2 Common

SIMPLIFIED HARDWOOD STANDARD LUMBER GRADES

	FAS	SELECTS	1 COMMON	2 COMMON	3 A	3 B
WIDTH	6" +	4" +	3" +	3" +	3" +	3" +
LENGTHS	8' - 16'	6' - 16'	4' - 16'	4' - 16'	4' - 16'	4' - 16'
No. of cuttings allowed	$\frac{SM}{4}$	$\frac{SM}{4}$	$\frac{SM + 1}{3}$ (not over 5)	$\frac{SM}{2}$ (not over 7)	No limit	No limit
Minimum size of cuttings	4" X 5' or 3" X 7'	4" X 5' or 3" X 7'	4" X 2' or 3" X 3'	3" X 2'	3" X 2'	1-1/2" X 3'
Amount required CF cuttings	10/12	10/12 FAS good side-- 1 Com. or better on poor side	8/12	6/12	4/12	3/12 (sound cuttings)
PITH	Length in inches no greater than SM	Same as FAS	1/2 the length	No limit	No limit	No limit

For definitions see instructions

Extra requirements for FAS and Selects:

Splits - Can be up to 2 x SM in inches length.

Wane - Can be up to 1/12 SM total and must be less than 1/2 length of piece on either edge.

Maximum size of knot or hole - 1/3 SM in inches.

End defects - at least 50% clear face, maximum of 25% unsound wood or wane.

Cutting Units Required for Extra Cutting

Lumber Grade	Lumber Size SM	Cutting Area %	Cutting Area Units	Number of Cuttings
FAS	6' - 15'	91-2/3	SM x 11	(SM/4) + 1
No. 1	3' - 10'	75	SM x 9	(SM+1)/3 + 1
No. 2	2' - 7'	66-2/3	SM x 8	(SM/2) + 1